National Sustainable Agriculture & Natural Resources Conference

1990 State Sustainable Agriculture Initiative Reports

Preliminary Summary

Extension Service, U.S. Department of Agriculture, Washington, DC 20250

1990 STATE SUSTAINABLE AGRICULTURE INITIATIVE REPORTS

PRELIMINARY SUMMARY

Compiled by: Dixon D. Hubbard
Manager, Competitiveness of American Agriculture

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ARKANSAS

OVERVIEW

We are struggling like many others to produce a good working definition of sustainable agriculture and what that means to Arkansas farmers and to our Extension programs. Our current view of sustainable agriculture is an agriculture that is environmentally sound and economically viable when carried out through integrated production systems. We agree with Dr. John Ikerd, University of Missouri, that it should remain productive and useful indefinitely. We have established an interdisciplinary task force within the Extension Service to address the nationwide Extension initiative of increasing the competitiveness and profitability of agriculture. To our mind, much of what sustainable agriculture is relates to this initiative. We have also established an interdisciplinary task force to deal with the initiative of alternative agriculture. The mission of these task forces is to determine Extension goals and educational methods in these areas. In addition to the task forces, the Cooperative Extension Service in Arkansas offers specific programs focused on the value and efficient use of legumes, animal manure, disease-resistant varieties, relay plantings, crop rotation, integrated pest management, natural pest control, and management systems which include alternatives to chemical pest control and inorganic fertilizers. Our goal is to establish information delivery systems to both commercial and limited resource agricultural producers that will increase their productivity and profitability while minimizing the impacts to the environment.

ACCOMPLISHMENTS

The University of Arkansas Cooperative Extension Service has made large strides in "sustainable agriculture" in the last several years. Two of our most significant programs are the Crop Research Verification Trials and the Reduced Rate Herbicide Program.

Research verification trials as an Extension teaching method were initiated in Arkansas in 1980. The purpose of the trials was to implement, demonstrate, and test Extension's research-based interdisciplinary recommendations in cotton, rice, soybeans, and wheat. An agronomy-oriented specialist is employed as a coordinator for the trials for each crop. The coordinator visits each trial at least once per week and initially makes recommendations in all areas of technology. After a year of experience, a locally designated Extension agent assumes the responsibility for decisions in consultation with the coordinator who continues weekly visits. The grower whose field is selected for a trial agrees to supply the land, equipment, and the management at no charge and to expedite all recommendations. Typically, a trial is conducted on a given field for two years compared with single-phased attempts at implementing technology. The coordinator/interdisciplinary crop system approach has been dramatically successful. The success of the program is a result of teamwork among crop producers, Extension personnel, and research scientists, special administrative support and direction by the University of Arkansas Division of Agriculture, and funding from many sources.

Between 1980 and 1989, a total of 259 research verification trials have been conducted. In the 1989 crop season, the yields of the 10 cotton trials averaged 841 pounds of lint per acre. This is 22 percent greater than the 1989 state average yield. In rice, 10 trials averaged 6,120 pounds per acre, which was 10 percent higher than the record state yield that year. The 10 irrigated soybean verification trials averaged 42 bushels per acre, approximately a 30 percent increase over the state irrigated average. In wheat, the 10 verification fields yielded an average of 49 bushels, or 12 percent greater than the average state wheat yield.

In addition to improving the efficiency and the level of production on these fields, one of the primary goals has been to lower input costs by reducing pesticide rates and fertilizer rates where possible. County Extension agents trained through these verification trials are able to disseminate this reduced rate knowledge to other farms in the county thereby maximizing the effect of the program.

Applied research on reduced rates for herbicides in Arkansas continues to show herbicide inputs can be taken lower and lower by substituting mechanical weed control spring narrow bands, targeting herbicides to the most susceptible weed species, and making very early applications. In addition, this

applied research is currently being implemented through written recommendations, computer programs, popular press, and producer meetings. Research in 1989 with band application and new cultivator equipment reduced herbicide costs from $21 an acre to $2.30 an acre, which shows the hypotheses of reduced herbicide inputs can be expanded further.

Along with these efforts, the University of Arkansas Cooperative Extension Service is an active participant in a regional LISA project to evaluate the potential of relay planting of soybeans into wheat. Research efforts with this concept have been ongoing in Mississippi for the last 3 or 4 years, and the results look promising. Although wheat yields are decreased from 10 to 20 percent with the relay planting scheme, relay planted soybean yields have equaled conventional full-season beans and show an increase yield potential of around 10 to 20 percent over double crop plantings. The entire effort of the Extension crop educational program is an attempt to provide the Arkansas grower with the most cost-effective production scheme possible with an end result of long-term economic sustainable production programs. In 1989, the Extension soybean educational program resulted in an estimated total cost savings of $11.50 per acre for those growers who participated in the program. As a result of this and other Extension efforts, a total net increase to Arkansas soybean producers from Extension educational programs was estimated at $50 million.

Cotton growers who enrolled in Extension's community-wide insect management and boll weevil suppression programs realized a $6 million savings in cotton pest management expenses specifically due to a reduction of pesticide applications. As a result of this effort, 200,000 acres of cotton were protected from promiscuous application of insecticides. Educational efforts on soil testing and plant nutrition help sustain cotton yields on 500,000 acres. A weekly program of cotton plant nutrient monitoring contributed to efficient fertilizer recommendations in an $18 million increased income on 243,000 acres.

Our educational program in rice helped increase the gross income of 5,000 rice producers by $54 million as a result of reduced inputs and sustained yields. Savings of $8 million worth of phosphorus fertilizer on 1 million acres of rice land resulted from soil testing and plant nutrition education. The effort resulted in the reduction of approximately one million pounds of phosphorus fertilizer which in turn minimizes eutrophication in streams, lakes, and reservoirs.

Soil testing for nitrates on 5,000 acres of forage land caused cattlemen to apply less nitrogen fertilizer, thus reducing forage production costs and protecting water quality. Animal waste disposal on pastureland is being encouraged to reduce commercial fertilizer costs and keep tame grass productive and healthy on soils low in fertility. This practice simultaneously lowers production costs for beef producers while recycling an undesirable waste product. In addition to containing the equivalent 50 pounds of nitrogen, 40 pounds of phosphorus, and 30 pounds of potassium fertilizer per ton, poultry litter also contains secondary nutrients and humus and is beneficial to forage plants as well as to such beneficial soil organisms as earthworms. The use of clovers has also been emphasized in pasture and hay programs to further reduce the need for commercial nitrogen fertilizer.

A cooperative effort between Oklahoma State University and the University of Arkansas has resulted in a printed newsletter that is distributed to county agents and farmers describing sources of information on low input methods that can be used on their farms. We are actively working in a joint effort in Texas and Oklahoma to disseminate information to vegetable farmers on reduced inputs in vegetable production.

An alternative crops technology effort has been initiated to support our limited resource farmers to provide options which reduce the chemical inputs and the associated costs but retain the quality levels which are required to enter the market place. On alternative crop technology demonstration farms, farmers are shown the beneficial results in improving the nutritional capacity of the soil by using summer and winter cover crops and soil test demonstrations in lime and fertilizer.

Over 50,000 soil samples are processed through county Extension offices to determine the lowest recommended rates of fertilizers for farm fields and home lawns and gardens. This effort has resulted

in a reduction of the accumulative rates of fertilizer on these sites. Such fertilizer recommendations have been a hallmark of the Extension Service for decades.

In other accomplishments, agricultural specialists have conducted training sessions this year on recertification of pesticide applicators, animal waste management, and dead bird disposal to over 250 county Extension agents. Nine study days/tours at Experiment Stations or demonstration plots involved discussions about reduced inputs and were attended by over 200 county agents. More than 130 letters or fact sheets that discussed minimum chemical inputs or alternative agricultural strategies were sent to 165 county agricultural agents during the past year. In fact, virtually all of our recommendations to our county agents and our clientele are aimed at the lowest inputs for maximum profit and yield.

FUTURE/OUTLOOK

Plans for the future include additional county agent training on animal waste management and reduced pesticide and fertilizer inputs, continued applied research on reduced pesticide rates, and added verification trials in beef cattle. Meetings and field tours of applied research plots and demonstrations will also be held. Opportunities will be taken with statewide media to promote awareness and discussion of these issues. The sustainable agriculture concept as currently discussed means that American farmers will have to gain an increased awareness of environmental concerns and implement the most efficient ways to utilize chemical inputs that are available. The Extension Service will have a greater burden in this area to provide education on the management skills and latest low-input pesticide and fertilizer recommendations to maintain the most efficient use of these inputs.

Sustainable agriculture and natural resource programs have been prominent for some years in the mainstream of agricultural education. The public's perception that sustainable agriculture means that farmers should revert to the agriculture of 40 or 50 years ago is not a viable alternative. With the combined efforts of the land-grant university research and Extension faculties, sustainable agriculture will continue to mean that farmers will make the greatest profit with the least inputs in an integrated systems approach.

CALIFORNIA

OVERVIEW

California agriculture is in transition. The most productive agricultural state in the nation is facing demands from growers, workers, government regulators, legislators and consumers to critically examine farming practices and their effects on the environment, rural communities, worker health, food safety and producer profitability. Sustainable agriculture is helping us to respond to these demands by promoting a transition to practices that maintain or enhance both natural and human resources while maintaining or improving profitability.

A broad range of farming and marketing practices are included under the term "sustainable agriculture", including production practices such as crop rotations, planting of legumes or cover crops, use of biological controls, reduced use of chemical or energy inputs, water and soil conservation and incorporation of livestock as an integral part of the operation. Sustainable agriculture also includes certain social values such as viable rural communities, fair and economically viable conditions for farm laborers, consideration of long-term land use and the threat of farmland conversion to other uses, and the health of all individuals touched by our food and fiber system. All of these practices and values are incorporated in the central goals of sustainable agriculture.

Attaining these goals is a process toward which we are now working in California. The University of California has been active in helping growers to meet the challenge of making the transition to more sustainable farming systems.

Sustainable Agriculture Research and Education Program

In 1986, at the request of the legislature, the University of California established the Sustainable Agriculture Research and Education Program (SAREP) to address the challenges facing the state's agriculture. The goal of the program is to support scientific research required for the development of more economically viable and environmentally sensitive agricultural practices and to disseminate this information to farmers, ranchers and other interested parties. The 1986 Sustainable Agriculture Act specifically defines SAREP's three main responsibilities:

- the administration of competitive research grants,
- the development and distribution of information, and
- the establishment of long-term farmland research sites.

Public and technical advisory committees were appointed to advise the university on SAREP goals and to make recommendations on the award of competitive grants. The Public Advisory Committee includes approximately 20 individuals actively involved in agricultural production (large, medium and small-sized conventional and organic growers), as well as representatives from government, public organizations, and institutions of higher education. The Technical Advisory Committee is made up of approximately 20 faculty, specialists and farm advisors throughout the state with knowledge and experience in diverse areas related to sustainable agriculture. This committee managed the program until agronomist Dr. William C. Liebhardt was hired in 1987. The Technical Advisory Committee continues to make recommendations about the scientific merit of grant applications and advise the program.

ACCOMPLISHMENTS

In the 3 years since its inception, the Sustainable Agriculture Program has made major progress in each of its three areas of responsibility.

Competitive Grants: Short & Medium-term Studies

A primary function of the program is to offer grant money for research and education projects. In the first three funding cycles (1987, 1988, 1990), 3,000 Requests for Proposals (per cycle) were sent out for plant and animal research and education projects.

Since 1987, 51 projects have been funded for approximately $1.2 million. The widely-ranging projects include studies of cropping systems, animal husbandry, pest and weed control, post-harvest handling, marketing, an analysis of organic farming practices, a comparison of work and labor in conventional and organic systems, videotapes on beneficial insect handling and soil management, and an introduction of sustainable agriculture practices into an urban gardening program. In 1990, the most recent funding cycle, $350,000 was awarded to 22 new research projects.

SAREP encourages interdisciplinary systems comparison research as an important part of its competitive grants program. These projects focus on an integrated analysis of soil, air, water, plant, animal, pest and economic management of whole farming systems. They require communication among problem-solving and systems-oriented researchers, innovative farmers, farm advisors and extension specialists. Although several projects have chosen to pursue systems comparison research, SAREP also funds projects in four other general areas: critical component research, information development and distribution, monitoring innovative production systems and field demonstrations.

It is estimated that these competitive grant projects probably capture 3.5 to 4 times their budgets in additional University resources. Projects which involve existing farms and ranches capture several hundred times their grant budgets (due to essentially free farm management and production costs) making them extremely cost-effective projects.

Competitive Grants: Long-term Farmland Studies

One of SAREP's responsibilities is to find out the effect of current agricultural practices on California's resource base. Studies are urgently needed to help answer questions about the long-term effects on the land. While the emphasis of long-term studies will be on research and data collection over a long period, information will be gathered and distributed continuously. The purpose of long-term projects is to establish field laboratories for ongoing studies of fundamental processes or mechanisms that influence the sustainability of agricultural systems.

Requests for proposals were sent out in September 1989 calling for a project that would establish at least one permanent site for long-term farmland studies. A project entitled "Long-term Research on Agricultural Systems: Crop Diversity and Input Level as Determinants of Function and Evolution of the Agroecosystem" submitted by a team of 18 researchers at UC Davis was awarded $150,000. This award is for 1 year only, and it is planned that UC Davis and the Division of Agriculture and Natural Resources will seek additional sources of funds to carry out research on the site on a long-term basis. The UC Davis College of Agriculture and Environmental Sciences has committed almost $550,000 in matching resources to this site over the next 3 years.

The long-term experiment will compare the performance of cropping systems with differing levels of applied irrigation water and nitrogen rates and sources. Nitrogen rates will vary considerably and nitrogen sources will include fertilizer, legumes and compost. Crop management guidelines and strategies for all treatments will be developed by a committee that includes both conventional and organic local farmers, the 18 investigators, a farm supervisor and staff research associate. Information from this project will be used to identify crop management systems that are both economically viable and not damaging to the environment.

Information Development and Distribution

One of the crucial needs in the agricultural community is for complete, accurate, up-to-date information and research results about more sustainable farming practices. To that end, SAREP has initiated projects that assess what we know and what we do not know, that make what is known more readily available, and that identify research needed to fill the data gaps.

The Database

Existing information from the university, farmers and other experts is being organized in a computer database. It is being reviewed by expert advisory groups composed of UC faculty, specialists, farm advisors, researchers from other institutions, private consultants and farmers. Information from the database is being prepared for distribution in publications. Ultimately, the same information will also be available in computerized form.

Conferences & Workshops

Information gathered by SAREP as well as current scientific research and practical applications is shared in conferences, workshops and symposia. In the last 3 years, SAREP has co-sponsored six commodity-specific conferences (grapes, citrus, organic vegetable production), two soil management conferences and eight general conferences (sustainable/organic farming, biological control, and making the transition from conventional to low-input agriculture). Additionally, SAREP organized a March 1990 symposium specifically for researchers, to report findings, assess progress and prepare for future systems research.

Publications

SAREP has developed information about the program and its research projects that is distributed to growers, farm advisors, researchers and consumers throughout the state. The newsletters and publications from the database, in particular, have helped interested farmers learn more about sustainable farming techniques and have contributed to a growing sustainable agriculture network.

Sustainable Agriculture News, a quarterly newsletter began publication in the fall of 1988. It is sent free to anyone who requests it, and has a broad audience of farmers, farm advisors, researchers, extension personnel and the general public. It reports on program research and activities, workshops and projects funded by SAREP. Components is a new technical quarterly newsletter that is being distributed to UC researchers and extension personnel on a trial basis. It contains brief summaries of articles from the scientific literature as well as summaries from conferences.

Other publications on groundwater concerns and citrus production, almond and walnut production options, cover crops, organic soil amendments, crop rotations, a videotape on cover crops and a document on the transition to sustainable agriculture, are in progress.

Media Coverage & Public Outreach

The program also reaches consumers, farmers and researchers through the popular press. Press releases about research projects, specific sustainable practices, workshops and symposia have prompted numerous print and broadcast news stories in California, the nation and the world. In 1989 alone, more than 50 news articles about the program's research and activities have appeared in national newspapers and magazines. Articles have appeared in the Los Angeles Times, San Francisco Chronicle & Examiner, Sacramento Bee, Fresno Bee, New York Times and People Magazine, among others. Other major media contacts include interviews with reporters from CBS, NBC, the BBC, PBS, Newsweek, Business Week, U.S. News & World Report, the Washington Post, Organic Gardening and Harrowsmith. Additionally, the program staff made more than 120 presentations at meetings, symposia, conferences and other public gatherings in 1989.

Cooperation with other UC Programs

One of SAREP's most important methods of collecting and distributing sustainable agriculture information is to work within the University of California system. It cooperates with a variety of other UC programs that also address sustainability issues including Agricultural Experiment Stations; Cooperative Extension; UC campus programs including Biological Control at UC Berkeley, the Agroecology Program at UC Santa Cruz, the UC Davis Sustainable Agriculture Program, the UC Davis Student Experimental Farm; and other programs including the UC Statewide Integrated Pest

Management (IPM) Project, and the UC Small Farm Program. SAREP also cooperates with UC faculty through their representation on special program advisory groups including Soils, Economic and Public Policy and Production Systems advisory groups.

Advisory Committees & Groups

In addition to the public and technical advisory committees mandated by the state legislature, the program draws on the expertise of many people within and outside the University of California for advice and planning in specific areas.

Economics & Public Policy Advisory Group

This group identifies how economics and public policy affect the sustainability of California agriculture. A broad range of UC researchers, specialists, growers, legislative representatives, outside consultants and experts attend advisory group meetings. The group is divided into four smaller subgroups which address specific subtopics including: land use, labor, rural community development, and agriculture and food policy.

Soils Advisory Group

In 1988, SAREP organized a multidisciplinary Soils Advisory Group made up of faculty members and researchers from throughout the UC system. The group has met twice to provide SAREP with advice on information collection and research on soil management as it relates to California cropping systems.

Production Systems Advisory Groups

Advisory groups on other topics and production systems are formed to advise the program and assist with development of the information base as necessary. They include a commodity group in almonds and systemwide groups in annual cropping systems and cover crops.

FUTURE DIRECTIONS

In the next year, legislation is pending which has the potential to significantly impact farming practices in California. SAREP will continue to address the critical needs for information and new options in agriculture through two means: systems-oriented and long-term research, and information development and dissemination. We plan to undertake the following activities:

Research: Short & Long-term

- Ongoing systems and component research and long-term farmland studies will continue to be supported.
- Animal issues (e.g., BST, antibiotics, bacterial contamination and animal welfare) are emerging issues which will need to be addressed.
- SAREP has identified the work initiated by the Economics and Public Policy Advisory Group as a priority in the next year. Dr. Patrick Madden has been hired at 25 percent time to coordinate the activities of this committee.

Information Development & Distribution

The Database

Information is being gathered for the database in the following areas:

- crop-specific information on grapes, walnuts, almonds and citrus; and
- manures, compost, crop rotations and cover crops for all systems. Cover crop activities, including data collection, conferences, workshops and publications are funded by the LISA program. All material will be summarized, reviewed and disseminated in publications to be distributed through ANR Publications.

Conferences & Workshops

SAREP is offering five training conferences in the 1990-91 DANR directory for extension advisors, researchers and the public: three on cover crops, one on crop rotation, and one on information management. Several additional meetings are being planned jointly with the Soil Conservation Service. The program will continue to cooperate with extension advisors and other organizations on regional meetings as opportunities arise.

Publications in Preparation

SAREP staff are preparing a number of publications for distribution through Agriculture and Natural Resources Publications including:

- Proceedings of Sustainable Agriculture in California: A Research Symposium, March, 1990;
- Sustainable Agriculture for California: A Guide to Information, revised;
- An Overview of Transition Agriculture;
- Crop Rotations;
- Organic Soil Amendments;
- Alternative Strategies in Soil Fertility and Floor Management in Almonds and Walnuts;
- Managing Citrus Orchards to Reduce Groundwater Contamination and a Cover Crop Manual.

In addition, five articles on ongoing sustainable agriculture research funded by SAREP will appear in "California Agriculture" in 1991. This is an opportunity for agricultural researchers to read about the latest sustainable agriculture research.

In the next year, we anticipate that changes in California agriculture will accelerate. UC SAREP, as one of the leaders in the sustainable agriculture arena, will be called upon more than ever to guide and direct agricultural research and education. The challenge continues. It is imperative that the University of California continues to take the lead in meeting the needs of the state's agricultural community with sound, research-based information for profitable, environmentally responsible production.

COLORADO

OVERVIEW

The concept or philosophy of sustainable agriculture has played a prominent role in Colorado agriculture and natural resource management. Although we have not adopted a statewide definition of sustainable agriculture, we all agree it is an agriculture that is compatible with the environment, is socially acceptable, reduces input costs and maintains profitability for the long term.

Colorado is somewhat unique as a state since all water originates within our borders and flows beyond its boundaries. Also, with our extensive agricultural systems, we generally do not have concentrated crop production over immense acreages such as encountered in the midwestern section of the country; hence we have not seen the accumulation of pesticides and nitrates in our water supplies as has been experienced in other parts of the country. This then has reduced the need for crisis management in Colorado and perhaps sustainable agriculture has been somewhat slower to catch on than in other regions of the country.

Nevertheless, there is a growing population of individuals in the state interested in agricultural impacts on the environment and solutions for the future. Some will argue that our research and Extension programs, as well as production agriculture, have employed the concept of sustainable agriculture for many years. Farmers have consistently looked for ways to reduce input costs perhaps not necessarily because of the effect on the environment, but more as a means to survival and profitability. As an example, chemicals used to control pests have become more concentrated such that only ounces per acre are now recommended application rates. Water management through the use of better irrigation practices is another example. Here at Colorado State University, we have an extensive program in irrigation water management designed to more efficiently utilize water for irrigation purposes. More than 80 percent of the water supply in Colorado is used for agriculture and it becomes imperative that best management practices be applied.

During the past several years, new linkages and alliances have been formed with non-traditional groups interested in the concept and philosophy of a sustainable agriculture. For example, several faculty at Colorado State University have established communication and working relationships with groups such as the Sustainable Mountain Agriculture Alliance (SMALL). This consortium of independent centers and institutes located across Colorado has interest in topics such as organic farming, reducing the use of fossil fuels, hydroponics, and alternative crops in an effort to balance a way of life more compatibly with nature.

Due to the interest being generated at the national level regarding LISA, in the summer and fall 1988, Colorado State University Cooperative Extension met with representatives of SMALL to plan a 2-day in-service training for Cooperative Extension agents and other interested individuals from the states of Colorado, Wyoming, Utah and Arizona. In February 1989 the conference was held in western Colorado with 80 attendees from the four states, approximately half of whom were Colorado Extension agents. For many, this was their first exposure to the concept of sustainable agriculture and it served to raise the level of awareness of our agents.

Concurrently, SMALL submitted a proposal to the Western Region LISA Program and received funding to conduct a survey of sustainable practices in the Southern Rockies. This study is presently being published in cooperation with Colorado State University and should serve as a directory and provide a network for those individuals employing sustainable practices ranging from low-input irrigation techniques to innovative marketing strategies. Unfortunately, at this point, all proposals submitted by Colorado State faculty have been denied through the Western Regional LISA Program.

In November 1987, through the assistance of the Colorado Department of Agriculture, the Colorado Organic Producers Association (COPA) was formed as a non-profit organization. The membership is comprised of individuals who choose to produce organically or have interest in this topic. In the spring 1989, an organic certification law was passed in Colorado establishing standards and procedures for

certifying agricultural products to be certified as organically grown or raised. Cooperative Extension has representation on the certification board.

In the fall 1989, a group of public and private interests formed the Colorado Sustainable Agriculture Network (COSAN). This network includes the Department of Agriculture, Colorado Association of Soil Conservation Districts, Colorado State University Cooperative Extension, Colorado Organic Producers Association and the Stewardship Community, including SMALL. In January 1990, COSAN hosted a conference entitled "Agriculture in Transition." The conference was attended by more than 150 people during blizzard conditions. The speakers were invited from states such as Iowa, North Dakota and Nebraska. Participants from the public and private sectors attended from numerous western states and included commercial displays promoting various biological or naturally-occurring products.

Another cooperative effort between Colorado State University and the Department of Agriculture is the specialty or alternative crops program. Through funding provided by private sources as well as grants from the Colorado Department of Agriculture, researchers, Extension agents and specialists established cultural practices for numerous specialty crops raised organically or conventionally. This past year some of these crops were raised on-farm in larger acreages. A video tape highlighting the most promising specialty crops has been produced and is available for sale through our Bulletin Room. Production information, including economic analysis and marketability, has been conducted for each of these crops. Future efforts will focus on marketing these specialty crops, whether produced organically or conventionally.

Recently, a bio-economic model for corn production was developed with an emphasis on reducing the need for herbicides. Extension, Experiment Station and ARS personnel are cooperating in developing this model, which will reduce the number of chemical applications and subsequently, reduce input costs. Another model is presently being developed which will be an expert system for barley production. The intent is to have these models be user friendly, so they can be employed in production agriculture.

ACCOMPLISHMENTS

A review of our accomplishments to date probably does not demonstrate dramatic environmental or economic impacts; nevertheless, there has been an opening of communication between non-traditional clientele groups and Cooperative Extension. Partnerships and networks have been established which will benefit all parties into the future. It appears as an observation that, especially within USDA agencies, sustainable agriculture has been emphasized at the national level; and consequently, agencies at the state level are becoming more involved. At times, this has created "turf" problems which we are discussing openly and cooperatively. While this situation can be viewed as a threat to Cooperative Extension, it has presented us with opportunities for cooperation and ultimately better information delivery to our clientele.

Into the future, some of our greater accomplishments may come as we determine agricultural impacts on water quality. As mentioned previously, pesticides do not appear to be a major problem in Colorado at this time. However, we have documented cases of nitrate levels exceeding standards. Through the use of improved production practices, water management, and historical tools such as soil testing, we should be able to alleviate these problems before they are of crisis proportion. In this regard, Colorado is at an advantage compared to some other states.

FUTURE/OUTLOOK

On campus, interest in sustainable agriculture is gathering momentum and a proposal has been submitted to the Dean of Agriculture proposing a Program for Alternatives in Sustainable Agriculture (PASA). While Colorado State University does not have a curriculum in sustainable agriculture, this proposal is to develop one and formalize the sustainable agriculture program here. In the meantime, an ad hoc group of faculty and graduate students have established a monthly newsletter disseminated statewide and host weekly seminars.

Monetary resources have severely restrained the expansion of a sustainable agriculture program here. However, numerous researchers and Extension personnel are deeply interested in a more environmentally compatible agriculture and much research and educational activity endorses this philosophy.

In summary, sustainable agriculture is alive in Colorado and at Colorado State University. Additional financial resources would assist greatly in moving the program along. Since appropriated money does not appear to be an immediate solution, efforts will be made to attract private funds to support many of our sustainable agriculture efforts.

GEORGIA

OVERVIEW

Agriculture is a key part of Georgia's economy. Livestock, poultry and crop enterprises return more than $5 billion per year to Georgia producers. Programs to ensure the continued profitability and sustainability of this key industry are major components of Extension programming.

The terms "profitability and sustainability" are inseparable in relation to the long-term survival of an environmentally sound agricultural production system that produces an adequate supply of food and fiber. Agriculture must be an efficient user of natural resources, not a non-user.

The University of Georgia Cooperative Extension Service has had a long term commitment to providing educational programs to improve efficiency in crop and livestock enterprises. A recently formed Profitability and Sustainability issue committee is charged with responsibility for identifying problem areas, agent and interagency training and public information regarding sustainable agricultural systems.

ACCOMPLISHMENTS

Master Cattleman Program - The "Master Cattleman" program was initiated as a pilot program in the winter of 1990. The program is a series of 7 evening meetings focused on improving the profitability and sustainability of cow-calf production in Georgia. The program provides producers with intensive, interdisciplinary training on the most recent advances in beef production. Rather than focus on one area, emphasis is the total management of a beef cattle enterprise and how to effectively integrate all available resources. The program also is in conjunction with the National Cattlemen's Association IRM (Integrated Resource Management) efforts. The program utilizes 13 specialists from 6 different departments. In its first year the program was conducted in 3 locations with 175 producers in attendance. Program evaluations have been excellent and counties are already requesting the program for 1991.

Energy Application of Agricultural Pesticides - During the past year, sprayer equipment clinics have been held for ground application and aerial application equipment. At these clinics, each participant's sprayer was evaluated for uniformity of application and calibrated. Detail discussions on mixing and loading sprayer and application techniques to prevent ground water contamination were included. Growers are made aware of upcoming legislation on mixing/loading and storage of agricultural chemicals. Attendance at these meetings totaled 1,195. Total land sprayed with the equipment evaluated at the clinics were l.9 million acres annually. Through practices advocated by this program, these applicators could reduce pesticide and application cost by $180,000.00 annually.

UGFERTEX-University of Georgia Fertilization Expert-Fertilizer requirements for agronomic crops are a function of many cultural, management and climatic factors. Yet soil fertility recommendations are often based on a "typical" soil under non-irrigated conditions. Georgia agriculture is characterized by a diversity of crops and farm enterprises. Crops are generally grown in rotation, with nutrient carryover effects from one crop to the next. UGFERTEX is an expert system which allows the user to interactively select from 28 agronomic crops along with various management practices. Then, based on soil test results, it uses functions for soil management group, yield goal, irrigation, plow depth, soil buildup, prior crop and manure applications to revive lime and nutrient recommendations for the crop-soil group combination. Many of the required inputs are selected from pop-up menus, allowing rapid, error-free entry of information. Important input values are checked to insure they are within acceptable range. Calculated values are automatically updated whenever an item is changed, making it easy to see the effects of changes.

Georgia Soybean Production Efficiency Education Program - This comprehensive educational program has helped Georgia's 4,000 soybean producers increase soybean profits by 80 cents per bushel or $20,000,000 statewide. The program gets producers to assess production efficiency and explore ways to refine and improve soybean production efficiency. Special emphasis areas include: (1) a yearly update on efficient soybean production practices, (2) a decision-aid computer program for

selecting varieties best suited to field conditions, (3) support clubs for developing best management production practices (that are technically, economically and environmentally sound), (4) a production efficiency awards program for identifying and rewarding the most efficient production efforts, and (5) an industry state tour to show state-of-the art methodology for efficient soybean production and to Georgia agribusiness working in unity for efficient soybean production.

UGSLIDEX - The University of Georgia Soil Loss and Income Decision Expert - This user-friendly expert system assists users in their search for economically acceptable cropping system alternatives to reduce soil erosion. Based on user inputs for location (county), soil type, and erosion control practices, the program calculates the effects of over 400 user-selected crop and tillage options on potential soil losses. Crop rotations, tillage methods, and erosion control practices can be selected for up to five years at a time. In addition to erosion losses, the program calculates the economic outcome for selected cropping system based on current Cooperative Extension Service budgets. Economic inputs including price, expected yields, variable costs and fixed costs are easily modified by the user to reflect the user's current situation. Controlling soil erosion is a primary concern for farmers and society as a whole. The provisions of the 1985 Food Security Act requires that farmers growing crops on highly erodible land develop a general conservation plan by 1990, and implement the plan by 1995 in order to remain eligible for government benefits and payments. Most conservation plans which have been completed allow several alternative means of reducing soil losses. UGSLIDEX will assist these users in selecting the detailed crops, tillage methods, and erosion control practices which will result in an agriculturally sound and economically sustainable cropping system.

County Agricultural Strategies - The county agricultural strategies program is designed to determine the status of agriculture in a county by identifying profitable and potentially feasible enterprises through use of budgeting and computer spreadsheets. The audience for this program is the county agricultural leadership, agribusiness, county government and others interested in agriculture.

The program involves the establishment of steering committees for each major agricultural enterprise groups. It also provides comparative advantage and competitiveness measures for each enterprise scenario for low-input sustainable agricultural systems, and an optimum county agricultural plan.

Integrated Pest Management - The Georgia IPM program continues to be a model for success. Although the program has its roots in the 60's, through refinements and wide adoption, its principles are more relevant today than ever before. IPM incorporates intelligent pest control strategies that insure favorable economic, environmental and sociological consequences. IPM does not exclude the use of agricultural chemicals but advocates their discriminate use that balances protection and profitability with environmental integrity.

A recent independent study of the Georgia peanut IPM program revealed that 95% of Georgia's peanut producers identified the Extension Service as their major source of IPM information. This study further documented a $73.75 higher net return per acre for "high" users of IPM when compared with non-IPM users.

Sustainable Agriculture Demonstration Farm - In the fall of 1989, wheat demonstrations were initiated on the Wakefield Farm in Hart County where wheat yields average less than 30 bushels per acre. The demonstrations included comparisons of varieties with natural or specific pest resistance versus the use of pesticides. Demonstrations also included plots comparing planting dates and tillage effects on wheat yields. In the initial results, average yields have increased from less than 30 bushels per acre to over 50 bushels per acre. Yield increases resulted from changes in management practices that are considered low input and impact minimally on the environment.

Pesticide Storage and Handling Facility - A Sunbelt Exposition Pesticide Static Storage, Mixing and Loading and Handling Facility has been developed.

The development of a Mobile Pesticide Exhibit will include all major phases of pesticide use in agriculture and will present information concerning food safety and environmental quality. A 5-year

sustainable agriculture farm plan will be developed for the Sunbelt Ag Expo Site. Over 200,00 people visit this site each year.

Low-Pesticide Apples - Utilizing new and emerging insect detection technology, combined with rigorous orchard sanitation and a post-harvest wash has enabled participating apple growers to drastically reduce pesticide inputs while producing a table grade fruit without loss of yield or quality. Reduction in pest control cost averaged $140 per acre by substituting scouting and management for preventive pesticide use.

Biological Control of Musk Thistle - The first Georgia release of a host-specific insect, musk thistle weevil, to control the widely spreading noxious musk thistle occurred in Georgia in May. If the weevil successfully establishes and reproduces in Georgia, over time more than $2,000.000 can be saved annually in control cost plus a reduction in the use of dioxin-containing herbicides by over 100,000 pounds.

OUTLOOK

Continued profitability and sustainability of agricultural enterprises is important to maintain economic well-being and quality of life for Georgia citizens. Agriculture must coexist with a growing urban population rightly concerned with safety of the food supply and water and air quality.

The Land Grant University System has provided the research base, taught the students and extended information to farmers that has enabled the development of the most efficient agricultural production system in the world. We must now take a fresh look at our agricultural systems in light of new public concerns. The teaching, research, and extension components of the system must work cooperatively and in concert with other agencies and public entities to evaluate current systems and develop and implement new integrated crop and animal production programs that do not negatively affect the environment.

Education will continue to be a key link in extending information to improve current systems and implementing the new production systems that will be developed. Internal agent training, interagency training and effective public information systems will be essential.

ILLINOIS

OVERVIEW

Research and extension education programs in the UI College of Agriculture have provided the foundation for continued progress towards the goal of agricultural sustainability. The many programs which have addressed agricultural sustainability have been documented by the first Coordinator for Sustainable Agriculture, Dr. H. J. Schweitzer in the paper "Sustainability and Research Thrusts at the University of Illinois" published in the Fifteenth Annual Illinois Crop Protection Workshop, March 7-9, 1989. In this review, Dr. Schweitzer describes modern initiatives in conservation tillage, integrated pest management, and other UI programs that deal with both short-term productivity and long-term sustainability.

Previous UI College of Agriculture research and extension education programs have been particularly successful at assisting farmers increase crop and animal production, improve short-term efficiency, and provide consumers with a reasonably priced, plentiful food supply. The College has an opportunity to further demonstrate social responsibility, by increasing our efforts to eliminate the environmental degradation and natural resource depletion associated with production agriculture.

The University of Illinois College of Agriculture has chosen to address the negative environmental impacts of agricultural production systems through the emerging science of agro-ecology. Much of the confusion and controversy over low-inputs, sustainability, profitability, and productivity disappear when ecological principles and measures are used to study agricultural systems. Agro-ecology can provide a scientific evaluative framework for complex systems with multiple objectives. Cooperative programs among production agriculturists, sociologists, ecologists and others will improve our understanding of agricultural ecosystems. Implicit in agro-ecological research and education is the suggestion that knowledge of ecosystem relationships will allow farmers to manipulate inputs and processes in agricultural production systems and thereby optimize for productivity, sustainability, stability and social equity.

AGRO-ECOLOGY AND RELATED PROGRAM ACTIVITIES

The following is a partial list of activities sponsored by the UI Agro-Ecology Program and related programs in the College of Agriculture. These programs were recently initiated, therefore accomplishments will not be discussed.

Agro-Ecology Network

The College of Agriculture ad hoc Committee on Sustainable Agriculture was established in November 1988. There were 17 original members of the ad hoc committee nominated by Department Heads in the College. Inquiries and expressions of interest from faculty, staff and students throughout the university have extended this "committee" to a network of over 200 individuals. In addition, farmers, government officials, and other agricultural leaders in Illinois have become part of the growing network of people interested in agro-ecology. Today, only 57% of those in the agro-ecology network are directly affiliated with the UI College of Agriculture. The original committee of 17 has quickly grown into a campus- and state-wide coalition.
The following committees in the UI Agro-Ecology Program have been organized:

- Newsletter
- Seminar
- Slide set Development
- Resource Guide Development

Agro-Ecology Seminar Series

This series was initiated in 1989 to bring well-known speakers to the UI campus to discuss national and global issues. The following speakers and topics were presented during the 1989-90 academic year.

- The Mission and Goals of the Leopold Center for Sustainable Agriculture: Dennis Keeney, Leopold Center, Iowa State University
- Sustainable Agriculture: The Role of the UI College of Agriculture; W.R. Gomes, Dean of Agriculture
- A Systems Approach to Sustainable Agriculture; George Bird, Michigan State University
- Groundwater: The Link to Sustainable Agriculture; Gerry Paulson, McHenry County Defenders
- The Marriage of Agriculture and Ecology; Wes Jackson, The Land Institute, Salina, KS
- Biodiversity and Agriculture; Peter Ravin, Director, Missouri Botanical Garden
- Industry's Concerns About Water Quality; John Thorne, Alliance for a Clean Rural Environment
- An Industry Response to LISA; Harold Reetz, Potash and Phosphate Institute
- Pesticides and Public Policy; Leonard Gianessi, Resources for the Future, Washington, DC

Sustainable Agriculture Discussion Groups

This series of informal discussion sessions was initiated in 1989 as an opportunity for interested faculty, students, and staff from the entire campus to share ideas on agricultural sustainability issues. The following discussions were held during the 1989-90 academic year:

- Agroecology - An Introduction
- A Review of Family Farming: A New Economic Vision
- The Agro-ecology Research Agenda: An Agriculturist's Perspective
- What is NOT Sustainable about Illinois Agriculture?
- Terraces in the Andes for Soil Protection
- Benefits, Costs and Risks of Pesticides
- Two Reviews of Alternative Agriculture
- Alternatives in Pest Management

Sustainable Agriculture in Eastern North America: Lessons from Natural and Human History; Prospects for the Future

This series was organized as evening seminars in 1989-90 and will be offered as a credit course in the UI Continuing Education Program in 1990-91.

- Climatic Changes of the Last 20,000 Years
- Natural History, Early Human Presence, and Native American Agriculture
- Land Drainage and Conflict Resolution in the Illinois River Bottoms 1890-1930
- Wildlife and Agriculture 1880-1980
- Soil Formation, Erosion and Crop Productivity
- Farmers' Attitudes Toward the Future
- Pests and Pest Management: The Impacts of Human, Pest, Crop and Technological Dynamics
- Technology, Social Change and Indigenous Knowledge
- A Prospect for Sustainable Agriculture: Energy Farming

Alternatives in Pest Management Conference

A conference was held on November 20-21, 1989, on Alternatives in Pest Management. The purpose of the conference was to examine pest control options available to farming and urban communities. The workshop focused on practical, unbiased evaluations of health, safety, and environmental factors as well as the effectiveness and economics of using alternative approaches.

Symposium on Sustainability: Agriculture and Society

A symposium was held on March 8-9, 1990, in recognition of Dr. Harvey J. Schweitzer, the first Coordinator of the UI College of Agriculture Sustainable Agriculture Committee. The invited speakers at the symposium included:

- o Dr. Vern Ruttan, University of Minnesota
- o Mr. Denis Hayes, Coordinator of Earth Day 1990
- o Mr. Charles Hassebrook, Center for Rural Affairs

Agro-Ecology Program Paper Series

This series of discussion papers was initiated in 1989 to encourage dialogue among people interested in the economic, social and environmental impact of production agriculture. The following papers are available from the UI Agro-ecology Program:

AE 90-1 - Illinois' Annual Billion Dollar Soil Erosion Problem: A Challenge for Research and Education
AE 90-2 - Agro-ecology, Innovation and the Cooperative Extension Service
AE 90-3 - Nutritional Recommendations Should Promote Sustainability
AE 90-4 - Agricultural Sustainability and the University of Illinois: An Introduction to Agroecology
AE 90-5 - New Student Conservation Attitudes and Beliefs: Implications for Curriculum Development in the UI College of Agriculture
AE 90-6 - Sustainability: Agriculture and Society
AE 90-7 - An Executive Summary of: Alternative Agriculture, by the National Research Council, Washington, D.C. 1989, with two reviews
AE 90-8 - Why America Needs a Commitment to Organic - Sustainable Agriculture: A Consumer's Perspective

Agro-Ecology News and Perspectives

At present the Agro-Ecology Newsletter is mailed to over 5,000 individuals including: UI faculty, legislators, Vo-ag teachers, Illinois Farm Bureau, Soil Conservation Service, ASCS, FmHA, and individuals throughout the U.S. This is a 16-page newsletter that deals with issues relating to agricultural and societal sustainability. The following issues were published in 1989-90:

Volume 1, No. 1: Introduction to Agro-Ecology
Volume 1, No. 2: Low-Input Sustainable Agriculture
Volume 1, No. 3: Integrated Pest Management

Volume 2, No. 1: Economics and Sustainability
Volume 2, No. 2: Energy and Agricultural Sustainability
Volume 2, No. 3: Societal Sustainability
Volume 2, No. 4: Animal Systems

Research Initiatives

Although many of the ongoing research programs in the UI College of Agriculture provide information critical to sustainability of the farming community, only a few of the new programs will be described.

1. The Illinois Department of Energy and Natural Resources has funded 134 on-farm demonstrations and research projects in Illinois during 1990. Coordination and interpretation of the financial data obtained from these projects is being provided by faculty from the UI Department of Agricultural Economics.

2. A 5-year, on-farm, rotation study including winter legume cover crops and various tillage treatments has been initiated by faculty in the Departments of Agronomy and Agricultural Economics in cooperation with several farmers in Illinois.
3. A project initiated by faculty in the Department of Agricultural Entomology will investigate the use of lower than label rates of soil insecticides for corn rootworm control on farmers fields.
4. A cooperative project with Purdue University will evaluate the economics of sustainable vegetable production systems. This 2-year project has received funding from the Federal LISA Program.
5. An ongoing study in the Department of Agricultural Economics examines records from 161 Illinois grain farms. An analysis of 11 years of farm records indicates lower levels of inputs can be profitable under some circumstances. Future research will focus on the cost and returns from a larger sample of both grain and livestock operations. Detailed enterprise information, including input quantities and specific tillage, rotation, fertility and pest management practices from these farms will be evaluated.
6. The Illinois Fertilizer Research and Education Council is funding several projects in Illinois that relate to sustainable agriculture issues. Fertilizer use efficiency, soil testing, application procedures and the use of animal manures are being evaluated. This program is administered through the Illinois Department of Agriculture.

Extension Education Initiatives

Many ongoing programs within the Illinois Cooperative Extension Service support the objectives of sustainable agriculture. The following new extension projects were funded by the Illinois Department of Energy and Natural Resources in 1990:

- Boone County CES On-farm Evaluation of Alternative Weed Control Methodologies
- Lee County CES On-farm Demonstrations of Alternative Weed control Systems
- Illinois CES Region 2 On-farm Sustainable Agriculture Demonstration Project
- Scott County CES Youth Demonstration Project

Four new extension circulars have been developed on alternatives in insect management by faculty in the Department of Agricultural Entomology. Current titles are:

- Microbial Insecticides
- Botanical Insecticides and Insecticidal Soaps
- Insect Attractants and Traps
- Beneficial Insects and Mites

A series of Agro-ecology Factsheets have been developed in cooperation with the Soil Conservation Service, the Illinois Department of Agriculture. Current titles are:

- Benefits of Winter Cover Crops
- Weed Control in Sustainable Agriculture
- Selection of Winter Cover Crops
- Establishment of Cover Crops
- Management of Winter Cover Crops

FUTURE INITIATIVES

Among the many ideas and potential programs being discussed by the UI College of Agriculture are the following:

- a new undergraduate curriculum in agricultural systems ecology
- an interdisciplinary faculty program in agro-ecology with a M.S. and Ph.D. degree program
- enhanced efforts in on-farm and farmer-first research and education
- development of a long-term agro-ecological research site

Informal discussions relating to on-farm research and education programs continue with sustainable agriculture farm organizations in the state. These organizations are:

- American Farmland Trust
- Illinois Stewardship Alliance
- Illinois Sustainable Agriculture Society
- Southeastern Illinois Sustainable Agriculture Assoc.

KANSAS

OVERVIEW

Kansas State University (KSU) agricultural research and Extension programs continue to direct their focus to the long-term ability of the land to support plant and animal agriculture as they undergo constant revision based on new information. Current programs recommended by KSU are sustainable and are based on a resource-efficient agriculture focused on the fundamental principles of plant and animal agriculture. Past CSRS reviews of departments have pointed out that KSU must focus on understanding fundamental principles which apply to large and small farms in a similar manner. By understanding fundamental principles of agriculture, extrapolation of results across farm size, farm type and location become much easier to understand and apply. KSU has continued to incorporate principles of crop and animal agriculture that relate to reducing off-farm inputs into existing programs.

ACCOMPLISHMENTS

1. Extension organized a water quality task force in 1985. The task force identified educational program needs which would help to address water quality issues. Several Extension educational programs identified by the task force, have been introduced this past year to help reduce problems associated with private water systems and to prevent further contamination of our ground water. One such activity, an agricultural best management program, was introduced to help protect ground and surface water. This program was incorporated into our traditional educational programs for agricultural producers. For example, in programs in which agricultural chemicals were discussed, specialists added information on the importance of best management practices to protect our surface and groundwater. This educational message on protecting surface and groundwater reached 5,890 producers this past year. An educational program, Water Education for Teachers (WET), has been developed for grade school teachers.

2. Extension and research programs with increased emphasis in water and environmental quality have been initiated. Cooperative Extension has taken several steps to assure that educational programs in water and environmental quality are adequately addressed and fully coordinated with other agencies and groups. An Extension Environmental Quality Specialist and Coordinator has been appointed to coordinate Extension educational thrusts and facilitate interagency cooperation on environmental quality issues. Program development teams have been organized to provide leadership in non-point pollution, domestic water quality, and safe use of chemicals (Chemical Task Force).

   Farmers and ranchers are being encouraged to build groundwater and environmental protection characteristics into each farm plan and each agricultural practice. Educational efforts focus on the use of best management practices for agricultural chemicals that minimize risk and reduce the potential of loss either by run-off or leaching. A non-point pollution team serves as a focal point for integrating non-point pollution principles in all Extension programs related to agricultural production, protection, and marketing. Special attention is focused on tillage, erosion, and run-off control, safe use of agricultural chemicals and water and environmental protection. Information on how pesticides reach groundwater and surface waters was incorporated into commercial pesticide applicator training sessions last year. Environmental quality issues were addressed in a series of 21 public policy meetings on the 1990 Farm Bill.

3. Applying fertilizer according to soil test recommendations based on realistic yield expectations is emphasized at in-depth soils schools presented by Extension. A key component of nitrogen management is to add only the amount of fertilizer which will optimize crop yield. Any excess is regarded as a environmental hazard. Depending on the crop rotation and amount of applied manure and legumes grown in the rotation, nitrogen rate adjustments are key components in effective nitrogen management programs. Research has clearly shown that corn or grain sorghum following soybeans or other legumes need less fertilizer to obtain equivalent yields than do crops grown without a legume in the rotation.

Additional research is underway to quantify the release rate and absolute amount of nitrogen supplied by legumes. Research is also focused on nitrogen cycling and cultivated vs. native plant systems with the objective being to determine when nitrogen is released from the legumes so cropping systems can be optimally matched to nitrogen release. The profile nitrogen test is promoted as a measure of residual available nitrogen.

4. The conservation tillage program development team has instituted numerous educational programs to help farmers retain surface residue, minimize erosion and reduce nutrient run-off through conservation tillage systems. This includes such management practices as conservation tillage (including ridge-till), accurate fertilizer and pesticide placement, minimal chemical use, improved water management, precision fertilizer recommendations, improved soil and plant tests and biological control of pests.

   A multidisciplinary study of transport of agricultural chemicals through soil is a result of in-house grants program. Project leaders include an agricultural engineer, a civil engineer, and an agronomist. This project will facilitate the establishment of a long-term research site to study the movement of potential contaminants like nitrate, Atrazine, and Alachlor in and through soil.

   Contamination of water by agricultural chemicals (pesticides and nitrates) has prompted research to determine how chemicals reach water supplies and how contamination can be avoided. The movement of pesticides and herbicides in soil is being studied in the laboratory, greenhouse, and field to determine the effects of tillage, precipitation and soil type on chemical migration. Special emphasis is placed on regions with susceptible aquifers like the Great Bend Aquifer in Central Kansas and the Equus Beds near Wichita. Specialized facilities are being instrumented in Manhattan to thoroughly quantify the movement of chemicals in water under normal agricultural conditions. Minimizing the potential for groundwater contamination is of critical concern to research and Extension programs to minimize the impact of agriculture on the environment.

5. A program associated with sustainable agriculture in Extension has been led by a task force of that name. It has representatives from a number of departments and programs. The task force is working with the Kansas Rural Center and the Land Institute in evaluating cropping systems. These studies are designed to quantify the synchrony between the mineralization of organic matter, legumes supplied, nitrogen and nitrogen uptake by wheat and grain sorghum. Test crops include continuous wheat, continuous grain sorghum, and combinations of those crops in rotations that include forges and legumes in conventional and no-till systems. On-farm testing is not new. Cooperating Extension and Experiment Station personnel have done on-farm testing for years. County agricultural agents conducted 583 agronomic on-farm demonstrations in Kansas in 1988 and 1989 on such subjects as crop varieties, tillage systems, terracing, manure value, recycled lime sources, stubble cover, canola and pearl millet, legume rotation benefits, pasture management and renovation, and other topics. Many other programs were also conducted on farm demonstrations.

   Faculty have obtained two LISA grants through CSRS competitive grants. One deals with substituting legumes for fallow in U.S. Great Plains wheat production in a cooperative project with North Dakota State University. The other project is assessing phosphorus availability in low-input systems. Other grants from private foundations support resource-efficient agricultural systems.

FUTURE/OUTLOOK

Significant efforts have been made within the program to increase participation in seminars and programs for sustainable agriculture. Faculty and administrators have attended meetings at professional societies and at other land-grant universities, and people have come to KSU to discuss sustainable agriculture.

There is no question that we learn from farmers and from industry experience and research. The university has a very open attitude toward receiving and utilizing information to provide the overall judgment associated with programs. A number of county Extension agents are actively involved in working with farmers to help them as they move from one farming system to another.

LOUISIANA

OVERVIEW

Louisiana State University has a strong commitment to sustainable agriculture. Throughout the history of the University, the Cooperative Extension Service and the Experiment Station have promoted and encouraged agricultural activities that produce food and fiber on a sustainable and environmentally sound basis. The Louisiana State University Agriculture Center recognizes that agricultural production and management systems must be both sustainable and environmentally sound to benefit the agricultural community and the larger society.

There are many definitions of sustainable agriculture in current agricultural literature. However, there is little agreement on a correct definition. The definition that best describes our philosophy is as follows. It is the goal of the Louisiana Cooperative Extension Service to assist family farms in developing sustainable agricultural production systems that are economically viable, environmentally sound and consistent with good stewardship of the soil, air and water.

We recognize there are many competing uses for these resources and that trade offs exist between the competing uses. We also recognize that no agricultural system will be of benefit to mankind if it destroys the environmental resources on which it is based. It is our task to assist the farmers in developing management and production practices and farming systems that assure adequate supplies of food and fiber on a sustainable and environmentally sound basis.

Sustainable agriculture is an integral part of our educational program. All agricultural commodity and subject matter specialists of the Cooperative Extension Service are involved in the program. Commodity specialists integrate sustainable agricultural practices such as reduced tillage, timely application of fertilizers etc. into their production recommendations.

Subject matter specialist have developed programs in pest management, energy conservation and water quality. Farm management specialists are available to assist farmers in adjusting their farm business to changes resulting from increased emphasis on environmental considerations such as the swampbuster legislation.

Program Structure

The Director of the Extension Service has appointed Dr. Gerald G. Giesler, a farm management specialist, to coordinate the LISA program. In this capacity, he works with a committee of six specialists to develop and implement LISA programs. Additionally, a quarterly newsletter on LISA is published for all extension service personnel.

There is close cooperation between extension service specialists and our research counterparts. This cooperation has resulted in the development of two research proposals, which were submitted for LISA funding, and the development of an ongoing research project at the Rice Experiment Station entitled "Low Input Rice Production".

ON-GOING PROGRAMS AND ACCOMPLISHMENTS

The following list of sustainable agriculture programs is only meant to highlight our activities in sustainable agriculture.

- Reduced Tillage - Commodity Specialists of the Louisiana Cooperative Extension Service have promoted the use of reduced tillage and no-till in those crops where the practice is appropriate. Both on-farm demonstrations and experiment station demonstration plots have been used to promote this program. Farmers were invited to extension field days to look at the results of this practice as well as other recommended practices. In 1990, approximately 15 percent (103,770 acres) of the cotton planted, and 20 percent (400,000 acres) of the soybeans were planted using reduced tillage.

- Bonne Idee Rural Clean Water Program - The Bonne Idee Rural Clean Water Program is a joint project between the ASCS, SCS, EPA, LCES and the Louisiana Department of Environmental Quality (DEQ). This project, which was initiated in 1980, involves 65,000 acres of land and 230 cooperating farmers in the Bayou Bonne Idee watershed in Morehouse parish. The project is for a 15-year duration expiring in 1995. One of the goals of the project was to reduce non-point pollution by the use of grass water ways, buffer strips, and improve fertilizer, herbicide and pesticide management practices. In 1989, the Extension Service worked with 31 producers in this project on fertilizer management and 41 producers on pesticide management. Soil testing was used to monitor the fertilizer recommendation with particular emphasis on preventing over application of nitrogen. Proper pesticide management was emphasized stressing the use of trap crops, sprayer calibration of both ground and aerial rigs, insecticide use based on need as determined by threshold levels of the pest population, weed management and the use of least environmental persistent pesticides. Both parish extension agents and state extension specialists are involved in this project. The list of specialists who provide technical support includes specialists with expertise in: agronomy, soil fertility, fertilizer placement, cultural practices, engineering, water quality, pesticide and fertilizer contamination of aquifers, spray and fertilizer rig calibration, disease and nematode problems of crops and weed science. The quality of the water in Bayou Bonne Idee has improved substantially as a result of this project.

- Integrated Pest Management - Integrated pest management is an integral part of the extension environmental education program in Louisiana. We provide training on the safe and efficient control of pests to farmers, agricultural consultants, urban pest control operators, aerial and ground applicators, and chemical salespersons. Each year, we provide training to farmers in all agricultural parishes; to 210 consultants, aerial applicators and ground applicators; to 115 chemical salespersons; and to 620 urban pest control operators. Through these training programs we have been able to reduce the over application of chemicals in both agricultural and urban areas. An important component of our pest management program is the recommendation of pest resistant varieties, planting dates that result in decreased insect pressure and the recommendation of chemicals that have minimum environmental impact.

- Waste Management - The Louisiana Cooperative Extension Service has a number of programs in waste management and use of waste materials.

- Solid Waste and Waste Water - LCES works closely with DEQ and EPA to insure that all applicable regulations concerning solid waste and waste water disposal are understood by farmers, agricultural and forest commodity processors, other industries and municipalities. Use of waste as a source of macro and micro nutrients is facilitated by this program. In March 1990, we hosted a sewage sludge forum for 120 municipalities. Participants include the Environmental Protection Agency and the Louisiana Departments of Environmental Quality and Health. Many of the Municipalities are recycling waste on crop or forest land or have an interest in this activity. We are normally working with 12-15 municipalities and 20-30 businesses at any given time to recycle waste on crop and forest land. Some of the sludges have been used as a replacement for lime while others have been used for fertilizer content. Most provide organic matter for Louisiana soils that typically have less than one-half percent organic matter content.

- Livestock Waste - LCES works closely with poultry, swine, and dairy farms in waste management. We work closely with broiler producers in 15 parishes in developing dead bird disposal and litter management systems. Farmers are provided with technical information on dead bird composting, with technical information on the proper application rates of chicken litter on pasture and the economics of using chicken litter as an alternative to nitrogen fertilizer. Animal Nutrition specialists have provided the technical data on using chicken litter in beef cattle ration. An on farm demonstration was conducted in the winter of 1990 on fattening yearling cattle using chicken litter in the ration. Lagoon design and management information is provided to Louisiana swine and dairy farmers. The proper management of livestock waste is essential in order to maintain water quality of the state's streams, bayous and aquifers.

- Low Input Rice Research - Low input rice research is being conducted at the Rice Experiment Station, Crowley, Louisiana by Dr. Pat Bollich. The research was initiated in 1990 and is schedule to run through 1992. A tract of land was divided into six plots with each plot receiving different treatments. The following chart is the experimental design.

PLOT NUMBER	TREATMENT	DIFFERENCE TREATMENTS
1	Best management practices	control
2	Same as 1 except	no fertilizer
3	Same as 1 except	no herbicide
4	Same as 1 except	no insecticide
5	Same as 1 except	no fungicide
6	Same as 1 except	no fertilizer no herbicide no insecticide no fungicide

These plots were featured in a recent field day. The results of this experiment should be very useful.

FUTURE AND OUTLOOK

Sustainable agriculture by its very definitions indicates that it is going to be a vital force in agriculture if we are to have agriculture in the future. Sustainability has been and is an important component in Louisiana State University's Extension and Research programs. We feel that as the world population expands as all forecasts predict the demand on resources will be so intense, the issues of sustainability and environmental degradation will become more prominent rather than less prominent. As this report shows, we are deeply involved in extension and research that is directed at the sustainability of agriculture and at environmental improvement.

MINNESOTA

OVERVIEW

Issues of agricultural sustainability have become an increasingly important part of the research and education programs of the Minnesota Extension Service (MES). Farm productivity and profitability have always been the main focus of MES programs and will continue to play an elemental role in the future. Greater attention, however, is being placed on the environmental and social impacts of our agricultural systems. A number of activities have recently been initiated which put MES in a leadership role both within the University and throughout Minnesota for sustainable agriculture.

The Sustainable Agriculture Working Group was instituted to coordinate the sustainable agriculture activities of the University of Minnesota. The group has a half-time director and a full-time coordinator. Each department of the College of Agriculture has a faculty member represented on the board. MES partially funds the coordinator position and extension specialists are part of the group. They are actively involved in the group's activities and will continue to be as it develops into a Center and increases its efforts throughout the state.

Other Centers at the University having a large impact on agricultural sustainability which have the involvement of MES staff and funds are the Center for Agricultural Impacts on Water Quality and the Center for Alternative Crops and Animal Products. Both of these Centers conduct research and outreach projects which can make an important contribution to a more sustainable agriculture by seeking ways of protecting our precious water resource and by diversifying our farm economy.

Minnesota has a number of state agencies which fund sustainable agriculture projects. MES staff are involved with many of these projects in a number of ways including: 1) serving on advisory and review panels to these agencies; 2) specialists are part of interdisciplinary research teams, and 3) county agents working with on-farm demonstration and outreach program with farmers and non-profit sustainable agriculture groups. LISA-funded projects also have extension staff as principle investigators or as part of a team of researchers. Projects have been funded in the areas of rotational grazing of livestock, spring nitrogen testing, conservation tillage, integrated pest management on apples and other crops, mechanical weed control, using a rye cover crop to control weeds, and others, all with MES participation.

A 2-day conference was recently held for all the county extension agents in the state on the subject of sustainable agriculture. Funding for the event came from a joint effort from MES, the Minnesota Department of Agriculture (MDA), and the State Board of Technical Colleges. Over 250 agricultural professionals from these organizations listened to speakers from throughout the Midwest discuss sustainable agriculture research and outreach programs related to crops and soils, weed control, animal production, farm management, and many other topics. This conference, which was a first of its kind in the Nation, shows the commitment that MES has to the principles of sustainable agriculture.

ACCOMPLISHMENTS

MES agriculture specialists from throughout the University are conducting research which will contribute to sustainable agriculture. To describe all of the work being done goes beyond the scope of this paper. Following are examples of projects and activities that have been completed or are underway:

1. **Water Quality**

   The Anoka Sand Plains project extends throughout 11 counties of east central and central Minnesota and consists of sandy soils typically low in organic matter and clay content over shallow, surficial aquifers. Because of the soils and hydrology of this region, there is a relatively high potential for contamination of aquifers by nitrates and certain pesticides through both point and non-point pollution.

The overall objective of the project is to encourage farmers on the Anoka Sand Plains to adopt management practices, developed through research, that can be used to reduce groundwater contamination. Results will be used to help others throughout the county who farm sandy soils to use best management practices.

The project is a major demonstration, education, and information cooperative project with major leadership shared by the Agricultural Stabilization and Conservation Service, Soil Conservation Service, and MES. Cooperation from other Federal, state, and local agencies is also a part of this project.

Work has begun on achieving the following goals:

a. A complete economic analysis of Best Management Practices (BMP's) for the area.

b. Adoption of BMP's by producers not in the program but located in the 11 target counties.

c. Using this project to serve as a pilot for other Minnesota counties and states to draw upon.

d. Providing Minnesota County Commissioners and others involved with County Comprehensive Water Planning a framework for establishing intensive educational programs for Best Management Practice adoption.

e. Involving farmers and other participants in educational and information programs as resource people to relate their observations, experiences, and opinions.

The Southeastern part of Minnesota is another area where groundwater is very susceptible to groundwater contamination. In 1988, LISA funds were awarded to an MES soil scientist to conduct on-farm research integrating conservation tillage, animal manures, and cultural pest control in corn.

Objectives of the study were to:

a. Explore and evaluate management alternatives for low-input corn production using ridge-tillage and farm manures.

b. Investigate the potential for reducing nitrate and pesticide pollution of groundwater by substituting manures for anhydrous ammonia.

c. Determine whether reasonable rates of applications of manure and different tillage practices affect survival of corn rootworms, attack by European corn borer, and weed populations.

Data has already been compiled on the first 2 years of the project and have been presented to both farm groups and county extension staff. Nitrogen movement in the soil, corn rootworm control, weed and earth worm populations are all being monitored as part of the study.

2. **The Koch Farm**

In 1988, the University gained access to a unique 160-acre tract of prime Minnesota farmland. Its location, history, and soil types make the site ideal for sustainable agricultural research.

3. **Decision Case Studies**

One of the ways to focus research and teaching on the problems of farming, is the decision case method. It's an especially appropriate tool for sustainable agriculture, with its focus not only on the individual farmer, but on the environment, rural communities, and society.

The decision case ideally teaches problem-solving while integrating research data with social and ethical considerations. In agriculture, decision cases effectively bring a farmer's experience -- which a scientist cannot duplicate -- into the classroom. For sustainability issues, decision case research and teaching helps farmers analyze and decide among conventional and alternative farming methods.

MES staff have been writing and reviewing decision case studies and have participated in national meetings on the subject. Cases have been written on topics of weed control, nitrogen use, and farm diversification by extension staff.

4. **Sustainable Agriculture Symposia**

Twice in the last 3 years, the Sustainable Agriculture Working Group and MES has sponsored a day-long symposium where faculty came together along with people from outside the University to report on their work and how it relates to agricultural sustainability. The sessions included presentations on earthworm populations, farm commodity programs, aquaculture, animal welfare, living mulches, and many more. This activity will continue in the future with an expanded format that will include more staff from both within and outside the University community.

5. **Rotational Grazing of Livestock**

The University of Minnesota was awarded funds to conduct research in the area of rotational grazing (RG) of dairy cattle from the USDA's Low-Input Sustainable Agriculture program. The grant, which was a cooperative effort between the Univ of Minnesota, Univ of Wisconsin, Land Stewardship Project, and the Wisconsin Rural Development Center, will fund research on experiment stations in the two states and up to 15 on-farm sites. Decision case studies are also part of the project. They will be used as an analytical tool to assess RG for some of the farmer-cooperators that are involved. An extension-forage agronomist and farm management specialist from MES are part of the project.

6. **University/Citizen Dialogue**

The University of Minnesota's location in the St. Paul/Minneapolis metropolitan area, makes for easy interaction with groups from traditional agricultural industries as well as non-profit advocates for sustainable agriculture. College of Agriculture and MES representatives have met regularly with leaders of the states' sustainable agriculture groups over the past few years. The result is enhanced mutual understanding of people and goals and co-sponsorship of research projects associated with sustainability. A survey and interview project of farmers' attitudes toward sustainable agriculture being conducted by the Land Stewardship Project and staff from the University of Minnesota is an example. Funding has come from the Northwest Area Foundation for this research.

Citizens involvement in many sustainable agriculture activities will continue and expand. Citizens will be included in advisory committees for the Center for Sustainable Agriculture and in the development of research projects for the Koch Farm.

FUTURE PLANS

The Minnesota Extension Service and the College of Agriculture will continue and expand its work on sustainable agriculture in the areas of:

1. Agent involvement with on-farm research and demonstration in sustainable agriculture practices.

2. Development of additional decision case studies, as well as further training in their use.

3. Create a Sustainable Agriculture Center within the University as an administrative home for multidisciplinary research, fund raising, curriculum development, outreach, etc., as it relates to sustainability.

4. Further strengthen the relationships already formed with people and groups from outside the University working in the area of sustainable agriculture.

MISSOURI

OVERVIEW

A sustainable agriculture is an agriculture capable of maintaining its productivity and usefulness to society indefinitely. This definition is the guiding concept for programs related to agricultural sustainability in Missouri. We contend that a sustainable agriculture must be made up of farming systems that conserve resources, protect the environment, support social progress and compete commercially.

Farming systems that fail to conserve their productive resource base eventually will lose their ability to produce. Systems which fail to protect the environment will degrade the productivity of their resource base and eventually lose their net usefulness to society. Systems that fail to support social progress by providing adequate supplies of safe and healthful food at reasonable costs are not politically sustainable. And, farming systems that are not commercially competitive will not generate the profits necessary for financial survival of producers.

We feel that farming systems must be both ecologically and economically sustainable. We consider both to be necessary, but neither alone to be sufficient, to ensure sustainability. We see no conflict between ecology and economics in the long run. However, conflicts can occur for individual farmers in the short run. Systems which promise maximum profits in the short run may not be ecologically sustainable. Systems that are ecologically sustainable may not be profitable in the short run.

In many cases, conflicts between ecology and economics may be resolved through effective integration of existing enterprises and technologies into more sustainable whole-farm systems. Some cases, however, may require development of new systems of farming utilizing new enterprises and new technologies. In still other cases, sustainability will require changes in government policy to resolve differences between social costs and benefits from farming and private costs and benefits to farmers.

In all these cases, we see a role and a responsibility for Extension to help farmers meet the challenge of sustainability.

Program Infrastructure

The Center for Sustainable Agriculture Systems (CSAS) serves as the primary coordinating entity for sustainable agricultural programs at the University of Missouri.

The objective of the CSAS is to enhance the environmental, social and economic sustainability of Missouri agriculture through:

1. Coordinating research and education activities in sustainable agriculture among private and public agencies and among individuals within Missouri.

2. Coordinating University of Missouri research and educational activities with Federally-funded sustainable agriculture programs.

Missouri's CSAS is supported by a 2/3 FTE, professor level, annual commitment of the College of Agriculture, University of Missouri.

The CSAS is currently coordinating 5 special projects with budgets totaling almost $500,000. CSAS also maintains information on 7 additional special projects with budgets totaling more than $200,000 plus an additional 50 regularly funded experiment station projects with sustainable agricultural aspects. CSAS has been involved directly in each of the programs listed in this report and in each of the programs and activities planned for the future.

CSAS has an advisory committee which includes two farmers (conventional and low-input), two representatives of agribusiness, and one representative each from Missouri Farm Bureau, Missouri

Department of Agriculture, Missouri Department of Natural Resources, Lincoln University and University Extension field staff. In addition, CSAS has an internal faculty advisory group with representatives from agronomy, soil science, entomology, IPM, agricultural economics and rural sociology.

Ongoing Programs

Sustaining and Managing Agricultural Resources for Tomorrow: Farm Resource Management System (SMART-FRMS). Formerly LISA-FDSS)

This is a national project to develop a microcomputer based farm decision support system. The objective of the project is to assist farmers in using the results of research and other available information in identifying, planning and developing whole-farm, multi-year resource management strategies; based on multiple objectives which include environmental risks, resource conservation, productivity and profitability. (A 2-year project funded through CSRS-USDA and ES-USDA, LISA funds.)

Sustainable Farm Financial Management Alternatives

This project supported the visiting professorship of Dr. Larry Bond of Utah State University at the University of Missouri to develop a resource management strategies (RMS) budgeting process and microcomputer program to support the SMART-FRMS program. A typical resource management strategy includes a basic crop rotation, a related tillage system, and input component all budgeted as one system. (A 1-year project funded by ES-USDA financial management funds.)

Implications of Sustainable Agriculture for Conservation of Non-renewable Energy

Regional models are being developed for existing and alternative farming systems addressing conservation, environment and economic issues for the various geographic regions of the United States. RMS budgets developed for the SMART-FRMS program will provide a foundation for this work. These regional models will be utilized in identifying the most promising lower input alternatives to current farming systems and potential implications of changes in farming systems on use of non-renewable energy. (A 2-year project funded by the Department of Energy, through ES-USDA.)

Policy Incentives Needed to Reduce Negative Environmental Impacts of Agriculture

The regional farming systems models developed under the energy project will be used to identify the commodities for which the smallest subsidies or penalties would be likely to result in the greatest positive impact on the environment from changes in farming systems. This project, like the previous projects, is closely related to and dependent upon use of the SMART-FRMS program. (A 2-year project funded by the Environmental Protection Agency.)

Initial funds from this project are being devoted to basic budgeting work, similar to that of the Energy project, but with emphasis on use of pesticides and nitrogen fertilizer in different RMS's for alternative cropping systems. This project is scheduled for completion in 1992.

Missouri Policy Forum on Agricultural Sustainability

A policy forum involving 35 selected representatives of Missouri agriculture was held in Columbia, MO, on April 23-24, 1990. An attempt was made to identify those aspects of the environmental issue upon which there is general agreement among those in the agricultural community. State level policy alternatives to address those issues were outlined and discussed. The primary objectives of this conference were:

A. To facilitate communications and promote better understanding among those with various perspectives on the issue of sustainability.

B. To provide Missouri legislators with valuable public input as they attempt to devise policies to address this issue at the state level.

Ross Jones Sustainable Agriculture Demonstration Farm

The Agricultural Experiment Station has devoted a 296-acre farm in north-central Missouri to demonstrate practical, usable sustainable farming practices. The farm has some land that can be farmed fairly intensively, some crop land with erosion problems and some land that will have to be used in pastures. The objective is to operate the farm as a typical farmer with a keen environmental and conservation interest would operate it. The farm has a very limited research budget. It will have to be operated at a net profit if it is to be sustainable as a demonstration, which perhaps is one of its most interesting and challenging aspects.

ACCOMPLISHMENTS

The SMART-FRMS program is on schedule and within its budget with a commitment to introduce an initial version at a national workshop in Omaha, NB, in August 1990. Dick Levins, University of Minnesota, is supervising the final phases of programming in cooperation with the Center for Farm Financial Management (FINPAK). The basic program concepts and a demonstration version of the program have been presented at professional seminars in 10 states and at two national conferences.

The SMART-FRMS program will be implemented in Missouri through an extensive training program for area specialists and through Missouri's Farm Business Centers program. The SMART-FARMS concept and demonstration program was presented in more than 20 counties in 1989-90, developing extension agent and farm level support for the training and implementation phases of the program.

At the national level, a joint project proposal with the Farm Financial Management Center at the University of Minnesota has been funded through ES-USDA, farm financial management funds to facilitate training, field testing, revision and integration of the LISA-FDSS program with the Minnesota FINPAK program which is currently being used in more than 30 states. A minimum of three regional interagency specialists training sessions will be conducted during the fall and winter of 1990-1991 to train state-level specialists to use the SMART-FRMS programs.

The SMART-FRMS, 6-member task force is made up of agricultural economists from 6 different states. An advisory committee of 7 additional people includes two farmers, an agronomist, an animal scientist, a sociologist, an agricultural engineer, a farm management specialist and two administrative advisors. A composite SMART-FRMS and FINPAK advisory committee will be formed in the fall of 1990 to coordinate training and field testing of the SMART-FRMS programs.

RMS budgeting formats have been developed, reviewed and revised in collaboration with the four Regional Farm Management Extension Committees and with the SMART-FRMS task force. A SMART Budget Planner program has been developed by Dr. Larry Bond, in collaboration with the Center for Farm Financial Management, and has been provided to cooperating specialists. The SMART Budget Planner is a microcomputer program designed to assist specialists in the 18 states who are developing prototype RMS budgets that will be used to introduce the SMART-FRMS system.

RMS budget cooperators from 18 states were recruited through meetings with each of the four regional Extension Farm Management Extension Committees. State representatives will be working with agronomists, soil scientists, entomologists and others in their respective states to develop RMS budgets.

The energy conservation project got underway in the spring 1990. Dr. Don Van Dyne, who has an excellent background in energy work, will be providing program leadership. Regional models will be developed using the 1987 National Resources Inventory survey which should be available in June 1990.

This project provides an important linkage between the Extension Service and the Department of Energy which may be important in addressing the issue of sustainability of energy sources. Budgets from the 18 states cooperating in the SMART-FRMS project will be used in this project also.

Initial budgeting work has begun on the environmental policy project and should be completed by mid 1990. Modeling and policy analysis is scheduled to get under way in the summer or early fall of 1990 with the project to be completed by mid 1991. This project provides an important linkage between Extension and EPA, which will be a key agency in all water quality projects affecting agriculture. RMS budgets from the eighteen cooperating states will support this project also.

A synthesis and summary of the Missouri Forum on Agriculture and the Environment has been prepared for distribution to key agricultural and legislative leaders and for publication in a forthcoming book on Missouri policy alternatives.

Forum participants included representatives of environmental groups, conservation groups, farm commodity associations, agribusinesses, the agricultural media, and individual farmers. All government agencies involved with the environmental issue attended the forum as observers.

Dr. Donald Osburn has been named managing director of the Ross Jones farm. A farm plan has been developed and the initial crops in various rotations will be planted in the spring of 1990. Plans to begin rotation grazing of stocker cattle on pastures this summer had to be delayed because of the lack of capital to purchase calves. The University is restricted from forward pricing which may be an obstacle to risk management, as in the case of purchasing stocker calves at record high prices. The farm should be ready for tours this summer and in full operation by the 1991 crop year.

An interdisciplinary advisory committee has been established for the farm. Several farmers have been recruited to conduct on-farm research and demonstrations that will complement those on the Ross Jones farm. Local legislative and agricultural leadership support of the demonstration farm has been excellent.

FUTURE PROGRAM OUTLOOK

Geographic Information System Pilot Project

A pilot project is under way in Livingston County, MO, to utilize Geographic Information System mapping to identify locations that present potential environmental and conservation risks. Information needed to determine the potential erosion of soils, their vulnerability to leaching and chemical runoff, their productivity and their current uses will be mapped for the northwest quadrant of the county. These maps will identify areas where erosion and water quality risks are greatest under current land use practices.

The SMART-FRMS program will then be used to identify alternative resource management strategies that might resolve potential conservation and environmental problems with acceptable outcomes including expected production and profitability. This information will then be used in developing site specific extension educational programs to confirm whether or not actual problems exist and to provide assistance in addressing problems in cases where farmers choose to pursue such solutions.

Sustainable Rural Economic Development

A planning grant has been approved to develop the research component of this project. A companion extension project will be planned simultaneously. The program development committee includes representatives from Community Development, Rural Sociology, Missouri Rural Innovation Institute, Agronomy, Entomology, and Agricultural Economics.

The basic premise of this program is that sustainable rural economic development must be rooted in utilization of geographically fixed resources, primarily agricultural lands. The concept of sustainable agriculture is extended to one higher level of aggregation, the rural community. A sustainable agriculture is viewed as one element of diversified rural communities with economies balanced between the security of relying on internal resources, local markets, and value added processing and the growth potential associated with linkages to external, global markets.

On-farm Research and Demonstration Programs

Plans for on-farm research and demonstration farmer networks are being developed in conjunction with the grass roots farm organization, Farm Alliance for Rural Missouri. The FARM group has received initial funding from the American Farmland Trust for 15 on-farm projects in 1990. The Missouri legislature has passed enabling legislation for 23 Resource Conservation and Sustainable Agriculture on-farm demonstrations for the 1991 crop year. A Hatch project will be developed to support a network of on-farm research projects during 1991-95. The FARM group, University Extension and College of Agriculture personnel will develop joint funding proposals for various potential funding sources to support on-farm demonstration and research programs in the coming years.

Management Systems Evaluation Area (MSEA) Project

A proposal has been developed to implement an extension complement to a major ARS-CSRS, University of Missouri research project. The MSEA project will monitor and assess impacts of alternative cropping systems on water quality in a watershed in north central Missouri. The extension program will inventory the natural resource base in the 20,000 acre watershed; including potential soil erosion, and pesticide and nutrient leaching and runoff risks; will survey current and planned land uses; including cropping systems, tillage and input use; and will identify potential site specific ecological problems.

Alternative resource management strategies will be evaluated to address potential problems, with specific consideration of economic and ecologic outcomes using the SMART-FRMS program. On-farm demonstration and other outreach programs will be used to reach farmers in the watershed with potentially useful research results and related resource management information.

MONTANA

OVERVIEW

In Montana, Sustainable Agriculture has been defined as systems which promise to maintain natural and human resources long into the future. In a high, cool, dry region like Montana, alternatives are somewhat limited and programs seek to help producers fine-tune agricultural operations in a manner which enhances economic production, promotes diversity and minimizes adverse impact on the environment and social structure.

Extension programs in Montana have been attuned to the concepts of sustainable agriculture, with emphasis on conserving soil and moisture; reducing adverse impacts on ecosystems, carrying out integrated resource management and helping residents of the state cope with change.

In the early 1970's, a small farmer program began to focus on problems and opportunities which have since emerged to encompass the philosophy of sustainable agriculture. At about the same time, AERO (Alternative Energy Resources Organization), The Institute of the Rockies, The Montana Land Reliance, and other groups began to advocate a closer study of the issues involved and also began to work with Extension. Farm operators began to explore alternative systems of production and expanded back into crops and livestock which were new to Montana, or had faded in the decrease of diversity which occurred after World War II.

Leadership and interest have emerged among producers, some of whom serve on Extension and Research advisory panels, and who have influenced expanded research and created a demand for diffusion of information through Extension. Searches of past research results and present research efforts are pointed toward assembling relevant information for operators in Montana. As interested has grown, other groups, such as GNBA (Great Northern Botanicals Association, OCAM (Organic Certification Association of Montana) and MAGPI (Montana Agri-Producers Association) have emerged. Advisory groups, on and off campus have provided input to help steer limited resources toward priority programs.

Program Infrastructure

The Extension Sustainable Agriculture Program is staffed by one specialist, with additional specialists providing backup in crops, livestock, marketing, forestry and other subjects.

There are also programs within other USDA agencies and the State Department of Agriculture which cooperate with, and complement the Extension effort. Close coordination with the ATTRA (Agricultural Technology Transfer to Rural Areas) program has taken place, with exchanges of information and initiation of programs which will enhance sustainable agriculture nationally.

Ongoing Programs

Cereal/Legume Rotations Research

Advisory groups of producers indicated that replacing nitrogen in the soil with the least possible depletion of moisture was a very high priority. George black medic, Berseem clover, and other legumes are being evaluated. Producers, Research and Extension personnel from the six states with large acreages of dryland cereal grains have developed research plots, demonstration sites and carried out tours throughout the region.

Some work is being carried out, in part, under a USDA LISA grant:

1. A literature search contributing to the six-state database.

2. Legume adaptation trials to determine the adaptability of several species of legumes to the various agroclimatic zones in the Northern Great Plains-Intermountain Region.

3. Field plot research to replace summer fallow with "ley farming" and/or conventional green manure legumes.

4. Research to find combinations of hay harvest and residue for plow-down, in order to recommend optimum benefits for producers.

5. To achieve the highest degree of non-chemical weed control possible through a combination of cutting techniques and intercropping with oats.

Information

Development of a database for the six states continues, with material being accumulated at Washington State University.

In cooperation with ATTRA (Agricultural Technology Transfer to Rural Areas), a number of alternative agriculture topics have been edited and placed on floppy discs, for the use of Extension agents, who then have the information immediately available on their computers.

Dr Jerry Nielson has developed a computerized mapping system which can help Extension personnel and producers evaluate climatic, soils, moisture and other conditions against the need of crops which may be considered for their areas.

Biopriming

Dr Nancy Callan of the Western Montana Research Center initiated research into the biopriming of seeds, such as super-sweet corn and beans, which are susceptible to damage from soil-borne diseases. She is in the second year of a LISA-funded study, in cooperation with other researchers in Oregon and Minnesota, and with local farmers.

ACCOMPLISHMENTS

Farm Tours and "Farm House Clubs"

Farm tours have been held at various locations in Montana for the last decade, expanding into Canada and surrounding states as appropriate. An average of 6 farm tours and open houses at each of the 7 Montana Agricultural Experiment Stations have been held annually.

After a modest start in 1989, a program encouraging producers to get together in local "Farm House Clubs" led to the formation of 7 such groups in the state in 1990. Local Extension agents provide support to groups of 6 to 10 farm families who meet periodically, tour each other's operations and travel to workshops and demonstration sites.

Biological Weed Control

Jim Story of the Western Montana Research Center, Extension personnel and cooperating landowners have carried out programs to evaluate and distribute screened and selected insects and diseases to control noxious weeds for the past two decades.

Workshops in Sustainable Agriculture

Starting in 1984, at least two workshops per year have been held, starting with very general discussions of sustainable agriculture and becoming more focussed as producers, researchers and Extension personnel have set priorities. From 50 to 180 producers have appeared at each of the two 3-day sessions.

Workshops have included: Marketing, alternative crops and livestock, green manure, agro-forestry, organic and low-input production, rotations, soil-building, overall rural community development, exotic crops and livestock and other subjects as suggested by producers and scientists.

Publications

The Small Farmer Newsletter was distributed for several years during the 1970's. The AERO Sun-Times began covering sustainable agriculture subjects during the same period and has emphasized sustainable agriculture for the past decade. The "Sustainable Farming Quarterly", a newsletter covering research and Extension efforts over the six-state region has also been published for the last year. Several university bulletins and journal articles have been published.

Dr. Charles Rust, Don Baldridge, and other Extension personnel have developed leaflets and audiotapes on a variety of alternatives, such as: flax, buckwheat, canola and similar crops.

Support to Other Groups

Extension has helped farmer-based groups secure grants from public and private sources. Approximately $1 million has been granted to AERO, MAGPI, GNBA, and other groups to carry on cooperative efforts with the land-grant university system. Sources include USDA LISA funds, State government funds, local government funding, the Northwest Area Foundation, Noyes Foundation and others.

There is also an alternative crops program to develop diversity in field crops, such as buckwheat, canola and various kinds of beans. We are looking at crops suitable for elevations from 4,000-7,000 feet.

Assistance to RC&D (Resource Conservation and Development Areas) has helped reduce irrigation water loss and power use through development of gravity flow irrigation systems.

Cooperation with Canada

Producers and scientists from the prairie provinces of Canada have been included in nearly every workshop and tour since the serious sustainable agriculture effort began. In part, it is because they have concentrated on alternatives, such as canola for many years, and because their programs have encouraged diversity in agriculture. Future plans call for continued close cooperation, joint ventures and planning partnerships.

FUTURE PROGRAM OUTLOOK

Water Quality

Funding for work in water quality will provide for educational programs related to clearing up of water quality problems at a number of sites in the state, all of which are closely related to sustainable agriculture efforts.

Sustainable Rural Development

Since many communities in Montana are experiencing declines in population, Extension and the cooperating agencies and non-profit groups will increase efforts to help local governments and community development groups.

Cooperation with Other Entities

As stated, cooperation with Canada, other states and private groups will expand and efforts to secure funding from a wide variety of sources will also be expanded, in order to develop more research and demonstration sites. A cooperative exchange with the Central Asian Republic of Kazakhstan in the Soviet Union is also planned.

University Courses

Courses which include information on sustainable agriculture are planned for Montana State University, and the University of Montana. Two of the Native American community colleges in Montana have expressed an interest in sustainable agriculture material as part of courses which help develop an integrated view of the biosphere.

On-Farm Research and Demonstration

Two research efforts are underway, to examine the economics and sociology of various farming systems during the next 3 to 5 years. It is hoped that results of these studies may help guide producers, researchers and Extension personnel in more effective sustainable agriculture programs.

NEBRASKA

OVERVIEW

A focus on sustainable agriculture and natural resources has long been integral to the Extension program in Nebraska. Especially in the areas of soil fertility, irrigation management, conservation tillage, integrated pest management, windbreak technology, and farm management, the concept of long-term sustainability has been a part of our Extension meetings and publications. With a growing concern about environmental dimensions of agriculture, including soil erosion, water quality, rural health and food safety issues, we have given even greater emphasis to designing and testing components and systems that are environmentally sound, resource efficient, and economically viable for the long term.

There is a multiplicity of definitions of sustainable agriculture, and little agreement on whether this is a set of practices, some desirable end results, or a philosophy. One recent definition: "Sustainable agriculture is a philosophy based on human goals and understanding the long-term impact of our activities on the environment and on other species. Use of this philosophy guides our application of prior experience and the latest scientific advances to create integrated, resource-conserving, equitable farming systems. These systems reduce environmental degradation, maintain agricultural productivity, promote economic viability in both the long and short term, and maintain stable rural communities and the quality of life" (Francis and Youngberg, 1990).

Among the programs that have been prominent in Nebraska Extension are the comparison of soil test laboratories, the conservation tillage research and demonstrations, the multi-location on-farm tests of applied fertilizer nitrogen, the Neighbor-to-Neighbor demonstration sites, and the collaborative workshops and tours with the Nebraska Sustainable Agriculture Society.

In recent years, University of Nebraska has brought together a number of information resources on sustainable agriculture. These are summarized in a list under accomplishments. The 1988 North Central Regional Conference on Sustainable Agriculture brought specialists from the 12-state region together to give reports and share ideas about this emerging area of interest. The second day of the conference was the initial planning meeting for the LISA grants in the North Central region. Since that time, University of Nebraska has been active in the organization and administration of the LISA grant program, and individual researchers and extension specialists have participated in a modest number of projects. These have included low-input cattle production systems, on-farm demonstrations of resource efficient practices, development of a videotape on
sustainable agriculture, and a 4-state workshop to share ideas among Extension specialists.

University of Nebraska, through the Institute of Agriculture and Natural Resources, is currently designing a Center for Sustainable Agricultural Systems. This center will integrate concerns and programs related to long term sustainability into existing research, teaching, and extension activities of the University. There is also a new book series from the University of Nebraska Press, an interdisciplinary series titled "Our Sustainable Future."

ACCOMPLISHMENTS

Sustainability is more than philosophy. It is a focus that has permeated the development of programs and practices at the University of Nebraska. Some examples of programs and results over the past two decades are described.

Beginning in the mid-1970s, soil samples from the same field were sent to several soil testing laboratories, including the University of Nebraska lab in Lincoln, and the precise fertility recommendations from each laboratory used on corn. These trials were continued with corn for more than 10 years and were repeated in several other Nebraska locations and with other crops. The bottom line was about twice the fertilizer expense using recommendations from commercial laboratories compared to the University, and yields that were not statistically different across the treatments (Agronomy Department, 1985). Results were widely publicized in Extension meetings around the state,

and this activity put Nebraska in the leading vanguard of integrated research/extension in resource efficient and profitable agriculture.

In parallel with this work, Extension was closely involved with conservation tillage research and demonstrations with farmers. Minimum and zero-till planting have rapidly been adopted on row crop acres in the North Central states, due in large part to the efforts of Extension. In Nebraska, this has included on-farm validation of research results, demonstrations, Area Conservation Tillage meetings in collaboration with SCS, and an Agricultural Energy Conservation Project.
Specific activities in addition to traditional meetings included planter/equipment demonstrations, coffee shop meetings, conservation tours, and rainfall simulator demonstrations. More than 11,000 people attended these events between 1983 and 1989. Production costs were at least $5 per acre lower in all no-till corn fields, while yields were equal or greater in 28 of 35 comparison sites (Dickey et al., 1989).

Energy conservation in crop production has been studied and demonstrated in a series of on-farm participatory trials in 1988 and 1989. Farmers work with the project technician to decide on least cost N levels and other planting system modifications. Over 2 years on more than 35 farms, there was only modest response to applied N in continuous corn and no response to N in corn following soybean, sweet clover, or alfalfa. A series of Extension meetings in collaboration with Nebraska Sustainable Agriculture Society was held in the eastern part of the state in early 1990, and a book of results made available to farmer participants. Crop Focus meetings have been held for the past 7 years in 15 locations each year to promote rational fertilizer and reduced chemical use in crop protection. Results from on-farm trials with starter fertilizer have clearly shown that this practice is rarely profitable in corn production.

The Neighbor-to-Neighbor conservation farming demonstration project was launched in 1989. Farmers volunteered to show practices that had been in the field for at least 5 years, eg. terraces or waterways, wildlife habitats, farm ponds, planned grazing or native grasses, improved pasture or hay management, no-till planting or conservation tillage, strip cropping, or other innovation. They agreed to invite other farmers to view their fields using a self-guided tour fact sheet and map. Several sites were used for formal Extension tours, and more than 350 farmers signed up to participate in the first year.

Cooperative activities with the Nebraska Sustainable Agriculture Society have included the on-farm trials described above, the joint Extension meetings, and a tour that has been scheduled for the past 8 years. This tour visited key farmer sites as well as the experiment stations run by the Agricultural Research Division of the Institute of Agriculture and Natural Resources. Between 80 and 120 farmers and others interested in resource efficient farming have attended these tours. Ag Expo at the ARDC, Mead, has featured efficient practices in the annual open house and tour.

There are a number of other unique programs, including irrigation scheduling, integrated pest management, rotational grazing options, integrative reproductive management in livestock, alternative crops and cropping systems that are a part of the Nebraska Extension program. In addition to meetings around the state, the district research and extension centers coordinate on-station, on- farm, and farmer-initiated research in each area of the state. Under one director, the research team and extension specialists in each district work closely together. The majority of appointments in the University are joint extension/research or teaching/research, another route to encouraging integration of programs and efficient transfer of information to farmers.

In summary, substantial research in the areas of soil fertility, alternative weed and insect management, reduced tillage, and breeding for genetic resistance to pests has been conducted in Nebraska that contributes directly to a more sustainable agriculture. Current research continues in these areas, with new emphases on cropping system design and management, reduced herbicide rates and alternative mechanisms for weed control, deep soil sampling and nitrogen budgeting, and participatory methods for on-farm validation of research results. Classroom and Extension activities related to sustainable agriculture are integrated into the mainstream courses and meetings around the state, rather than confined to a few specific activities directly labeled as "LISA". Much of this information has been summarized in these extension publications.

- Sustainable Agriculture ... Wise and Profitable Use of Our Resources in Nebraska. 1987. Agronomy Dept., Coop. Extension System, UNL ($7)
- Sustainable Agriculture in the Midwest: North Central Regional Conference Proceedings. 1988 Agr. Res. Div. & Coop. Extension System, UNL ($5)
- Questions and Answers about Sustainable Agriculture: Transcript of Satellite Video Conference. 1989. Agr. Res. Div. & Coop. Extension System, UNL ($5)
- Sustainable Agriculture: An Overview (100-slide set with narrative and supporting reference papers). 1989. Agron. Dept. UNL ($75)
- Sustainable Agriculture Videotape (23-minute video with transcript and supporting reference papers). 1989. LISA Project, UNL ($35)
- Resource Efficient Farming in Nebraska. 1990. NSAS and Coop. Extension UNL ($5)
- Specific topic papers presented or published over the past several years, all available from Dept. of Agronomy, Univ. Nebraska, Lincoln, NE 68583-0910 (see attached list).

FUTURE PERSPECTIVES

A growing awareness of the importance of sustainability and of the need for new measurements for success in agriculture and resource use is having an impact on Nebraska Extension programs. Some of the specific activities or changes anticipated in the University of Nebraska include:

- Development of a Center for Sustainable Agricultural Systems, with programs integrated into existing teaching, research and extension; planned for late 1990.
- National Conference on Sustainable Agriculture and Natural Resources scheduled for August 15-18, 1990, with numerous national and state-level co-sponsors.
- Initiation of one course and one seminar series on campus in the area of sustainable agriculture; planned for 1990 or 1991.
- Development of the Soybean Profitability Project that focuses on production costs, practices, and marketing.
- Initiation of a new book series, "Our Sustainable Future", through the University of Nebraska Press.

Presentations or Publications

(These publications and a more complete list are available from Department of Agronomy unless otherwise indicated):

- Sustainable Agriculture in Temperate Zones, C. A. Francis, C. B. Flora, and L. D. King, Editors. John Wiley & Sons, New York. 497 pp. 1990 (for sale from publisher)

- "Researching, teaching, and extending a sustainable agriculture", Leopold Center Conference Keynote, New Developments in Cropping Systems and Livestock Management Systems, Ames, IA, 1990. (C. Francis)

- "Participatory strategies for information exchange", Inst. Alt. Agr. Symposium Learning from Each Other: New Models for Agriculture Research and Information, Washington, DC, 1990. Amer. J. Alt. Agr. (in press). (C. Francis, J. King, J. DeWitt, J. Bushnell, L. Lucas)

- "Specificity: the context of research for sustainability", J. Soil & Water Cons., 45(1):55-57. 1990. (D. Walters, D. Mortensen, C. Francis, R. Elmore, J. King)

- "Contributions of plant breeding to future cropping systems", ASA Special Symposium and Publication, Plant Breeding and Sustainable Agriculture, Las Vegas, NV, 1989. (C. Francis)

- "Closing the information cycle: participatory methods for on-farm research", FSR/E Workshop Farmer Participation in Research for Sustainable Agriculture, Fayetteville, AR, 1989. (C. Francis, P. Rzewnicki, A. Franzluebbers, A. Jones, E. Dickey, and J. King)

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OVERVIEW

One of the most pressing ecological dilemmas of our times is the need to reconcile an ever-increasing world population with a realization that most of the world's resources are finite. As the world's population increases and centers of urbanization and industrialization continue to expand, there is an urgent need to utilize the natural resources of our biosphere in the most efficient and sensible ways possible. This need applies to both natural and agricultural ecosystems. For the past half century, agriculture in the United States has been characterized by a progression toward large-scale, monoculture farming practices with a primary emphasis on maximizing yields. Such high-production agroecosystems require enormous nutrient and energy subsidies in the form of inorganic fertilizers, pesticides, herbicides, and fuel to maintain their productivity. Although this approach to agriculture has produced unprecedented yields and has been profitable for many farmers, in recent years farming has fallen under heavy criticism for over-production, lack of economic stability, and environmental degradation. The environmental and ecological costs associated with intensive high-input farming practices include serious soil erosion, contamination of soil, food, and water resources with pesticides and fertilizers and destruction of many natural habitats as more marginal lands are forced into agricultural production. People are worried about contamination of their food and water and are realizing that current high-input conventional agricultural practices cannot offer long-term sustainability. Many agricultural scientists have, therefore, turned their attention to the potential of more sustainable agricultural practices based on lower-chemical inputs used in integrated farming systems.

Lower-input sustainable agroecosystems rely much less on high inputs of energy and chemicals and much more on internal biological processes and cultural methods to achieve long-term productivity and environmental compatibility. By changing management and cropping practices to maximize nutrient and energy use efficiency, relatively high crop yields can be maintained at a much lower cost to both the farmer and the environment. Lower-input sustainable systems differ markedly from conventional, high-input agriculture in that they emphasize long-term economic stability with minimal environmental impact rather than short-term goals such as maximum yields, at high costs to the environment. It is apparent that the goals of lower-input sustainable agriculture cannot be met by simply decreasing chemical inputs per se. Rather, successful low-input agroecosystems require informed management based on sound ecological and biological principles and a greater understanding of the complex interactions affecting agroecosystem productivity. Our program at The Ohio State University focuses on investigating these principles and disseminating existing and new information through extension and teaching programs.

Background of the OSU Sustainable Agriculture Program

The Sustainable Agriculture Program at The Ohio State University began in 1986 to promote a more energy-conserving, environmentally-sound, and economically-viable agriculture through research, education, and extension. There has already been substantial progress made in this program thanks to funding from several private foundations, a few state agencies, the USDA LISA program, and The Ohio State University.

Program Infrastructure

In July 1990, a formal interdisciplinary program on Sustainable Agriculture was set up and led by Professor Clive Edwards. The overall program is supervised by an Administrative Committee, and the program developed through a Technical Committee with four Subcommittees -- each with a leader in extension, research, resident instruction, and international activities.

ACCOMPLISHMENTS

We have had many accomplishments to date and have several ongoing projects which are listed below as either Research, Extension, or Teaching.

Research

Farmer Survey

In 1988, The Ohio State University's Sustainable Agriculture program submitted a list of questions to be included in a stratified random survey of 1,000 Ohio farmers being conducted by the Agricultural Economics and Rural Sociology Departments. Some very enlightening and useful information about their management practices and economics was gathered. For example, approximately 52 percent of the farmers surveyed, obtained their information on when and what chemicals to apply from chemical sales representatives, whereas only 30 percent received their information from University Extension personnel.

Information from this survey will prove very useful in planning outreach and educational programs.

Farming Systems Research Project

In this project, an interdisciplinary team of scientists is examining 11 different treatments representing varying levels of inputs (tillage, fertilizers, pesticides, rotations) which encompass the major factors and components of agroecosystems. These systems were designed to include both current conventional agricultural practices and innovative more sustainable agricultural practices and farming systems being adopted by lower-input farmers. The primary goal of this project is to evaluate these management systems in terms of ecological, agronomic, and economic factors so systems may be designed which both maximize the usefulness of agricultural land and minimize detrimental effects on food, water, and the environment. The research emphasizes the impacts of these different management systems on soil -- physical, biological, and chemical characteristics -- as well as impacts on water quality. We are documenting soil and water resource conservation on the site and the potential for degradation and pollution off the site. This project is a long-term one.

Watershed Water Quality Study

The program also received OSU Research Challenge funds for initiation of a watershed study which will compare the output of pesticides and fertilizers from a conventional farming system, an integrated lower input system, and an organic system using no synthetic chemicals. This project is being expanded considerably with large funds from the USDA Water Quality Program.

Ridge Tillage LISA Project

This project was funded in 1988 by the USDA LISA program. To demonstrate the control of soil erosion and the reduction of cultural inputs of inorganic fertilizers and pesticides, a low-input ridge tillage cropping system was established on typical Corn Belt farmland at the 996-acre Molly Caren Agricultural Center where the Ohio State Farm Science Review is held each September.

Comparison of High- and Low-Input Farming

This project was funded in 1988 and 1989 by the USDA LISA program. The experiments have been designed to evaluate and compare two crop rotations, corn-soybean and corn-soybean-wheat-clover, managed at three levels of chemical input:

1. A system using currently recommended practices and applications of manufactured fertilizers, herbicides, insecticides, and fungicides when needed.

2. A system using herbicides, insecticides, and fungicides, but substituting manure (before corn) for manufactured fertilizers.

3. No manufactured chemical inputs unless absolutely necessary to save the crop.

Two sites include all crops in both rotations each year to reduce ambiguities caused by different weather in different years.

Economic, Ecological, and Environmental Analyses of Farms Under Long-Term Lower Chemical Input Management

This project has been funded by the 1990 LISA program. The project will develop whole-farm economic budgets and document management practices for three family-operated low chemical input mixed crop/livestock and cash grain farmers; assess nutrient cycling and energy budgets of the farming systems in relation to biological, cultural, ecological, and environmental processes at the farm level; evaluate the influences of chemical and organic soil amendments on soil chemical, biological, and physical characteristics, pest disease, and weed incidence, and on crop growth; do economic analysis of the farming systems, and use results in extension activities.

Economics of Sustainable Agriculture

Several faculty have initiated a 5-year Hatch research project titled "The Economics of Sustainable Agriculture."

The general purpose of the proposed research is to assess the economic impacts of conversion to sustainable agriculture on the agricultural sector and on society as a whole. Specific objectives are:

1. To assess the current farm-level economics of sustainable agriculture in Ohio and elsewhere in the Midwest.

2. To estimate production response relationships for important Ohio cash grain crop species, including the interaction of tillage technique, rotation, and biological/chemical pest control.

3. To identify and measure the impacts of major factors affecting the demand for selected organically-grown foods and to assess the potential markets for the selected foods.

4. To evaluate the potential downstream and groundwater benefits in Ohio of conversion to sustainable agriculture.

5. To estimate the potential economic impacts on Ohio's rural communities of conversion to sustainable agriculture.

6. To evaluate the benefits and costs of soil conservation and reduced chemical applications in selected developing countries.

There are several other faculty members with research interest directly or indirectly related to a sustainable agriculture in almost every Department in the College of Agriculture.

Extension

International Conference on Sustainable Agricultural Systems

The Sustainable Agriculture program at OSU was established internationally through the organization of an International Conference on Sustainable Agricultural Systems in Columbus in September 1988 attended by more than 500 participants from 21 countries. The proceedings were published as a book "Sustainable Agricultural Systems."

Sustainable Agriculture Interest Group and Newsletter

The Sustainable Agriculture Interest Group has existed since March 1983 and has grown to over 400 Ohio members, in addition to over 300 out-of-state participants. Participants include faculty, students, extension personnel, state government officials, farmers, and interested community members. The quarterly meetings generally consist of information updates about Sustainable Agriculture in Ohio, and a presentation by a guest speaker or speakers. The group also publishes a quarterly Newsletter.

Farmer Mentor/Apprenticeship Program

The OSU Sustainable Agriculture program has received a 3-year grant from the George Gund Foundation to initiate a farmer apprenticeship program in Ohio. The apprenticeship program was proposed because of the increased number of phone calls received from farmers who would like to make the transition to a lower-input agriculture. The program aims to facilitate farmer-to-farmer interaction, exchange of information, and training. The program, which began this year, consists of a centralized introductory workshop, 3 regional workshops, and numerous summer field days for a group of "mentor" and "apprentice" farmers. Each "apprentice" attends a workshop in their region for technical information on soil fertility, cover crops, crop rotations, manure application, weed and insect management, whole farm systems, integrating animals, marketing, economics, diversification, and on-farm experimentation. The "mentors" for the program are successful farmers who have made or are making the transition to a more sustainable agriculture. Other specialists will be available at each workshop to answer questions, etc. During the summer, "mentor" farmers will host field days at their farms so the "apprentices" can view results first hand, ask questions, etc.

Extension Agents In-Service Training

In March 1990, the Sustainable Agriculture program and the Cooperative Extension Service sponsored the first annual In-Service Training on Sustainable Agriculture. The program included guest speakers, philosophical discussions, technical information, and the knowledge and experience of many farmers and scientists.

County Level Sustainable Agriculture Program

Several County Extension Offices have planned and sponsored 1-day conferences on various topics of sustainable agriculture and sharing resources.

Demonstration and Research Farm

In conjunction with the Ohio Department of Agriculture, the Sustainable Agriculture program is setting up comparative demonstrations and research on a 120-acre farm owned by the Ohio Department of Agriculture. The facility will include long-term comparisons of conventional, integrated low-input, and organic systems of production for agronomic crops, vegetables, fruits, and turf. There will also be relevant research conducted at the facility. In particular, the economics of the systems will be assessed on a farm scale.

Conversion Manual

Funding has been recently received to write a manual which will provide step-by-step instructions on how to convert from high-input agriculture practices to a more sustainable lower-input agriculture. It will list not only specific strategies and methodologies for lowering energy-based inputs, but also contain a resource directory, recommended reference sources, listings of suppliers and organizations which may be of service, appropriate University personnel who can offer advice, and regional case studies. The manual will be an essential educational tool, which will assist us in gradually changing the pattern of agriculture in the state. A somewhat related manual about university research knowledge about alternatives to high-chemical farming is in press by the Agronomy Department.

Seminar Program and Course

Seminar courses on environmental science are offered. A course on sustainable agriculture topics was offered, and others are planned.

Internship Program

A Student Internship Program was initiated this year with funding from the George Gund Foundation. Five students were admitted into the program. The focus of the program is "Research in Sustainable Agriculture." Students are working on ongoing projects either at The Ohio State University or on nearby farms. Individualized projects were made available which focus on: nutrient cycling, organic matter characterization and turnover, energy studies, weed ecology and control, soil ecology, economic analysis, or Amish agriculture.

The internship also includes weekly seminars and several field trips. Stipends were made available for participating students.

Curriculum Development

A committee has been formed to investigate the possibility of beginning a degree program in Sustainable Agriculture at The Ohio State University.

International Activities

Professor Clive Edwards was commissioned to write a report for the Congressional Office of Technology Assessment on "The Role of the Land Grant Institutions in Development Assistance: Possible Responses of U.S. Universities to Sustainable Agriculture as a Development Goal." He also chaired a committee which prepared a report "A Strategy for Developing and Implementing Sustainable Agricultural Systems in Developing Countries" which made recommendations for future activities of USAID. He and Professor Ruttan Lal are members of a National Research Council Committee on Sustainable Agriculture in Developing Countries.

FUTURE/OUTLOOK

The Sustainable Agriculture program at The Ohio State University is expanding rapidly and attracting additional funding and local and national attention. it is hoped that the 1990 Farm Bill will provide further impetus to these activities. Moreover, it is hoped that a "Sustainable Agriculture" bill before the State Legislature will provide additional support for the program.

We have received an endowment of $100,000 from Jack and Louise Warner, and there are plans to set up a foundation with similar aims.

We hope to become further involved in international sustainable agricultural programs through participation in USAID, CRSP.

We strive to reach and work with the entire College of Agriculture and to raise questions about sustainability for our modern agriculture and seek sustainable agricultural policies and practices.

OKLAHOMA

OVERVIEW

Sustainable Agriculture in Oklahoma is defined as a concept based on agricultural systems which optimize purchased inputs with profitable product output by utilizing ecological principles. End goals are (1) a productive and profitable agriculture, (2) soil and water conservation, (3) improving environmental quality, and (4) food quality and safety (Epplin 1989).

Sustainable agriculture activities at Oklahoma State University cut across departments and disciplines. Management of natural resources (eg. forestry, range) provide lessons for application to highly disturbed (eg. agronomic) settings. For example, OSU silviculturalists are examining options for timber management from intensive even-aged silviculture with artificial regeneration to low-cost management schemes or strategies in which timber is a secondary objective. Emerging systems utilizing natural regeneration or encouraging mixed stands are of interest for timber and wildlife or recreation, ie. merging of low-input and multiple-use principles. Agricultural engineers have joined forces with agronomists and agricultural economists to modify machinery which facilitates reducing the need for herbicides in minimum tillage wheat and other small systems. Drill modifications allow the wheat seeds to be sown in ultranarrow rows so the plant spacings are equidistant within and between rows increasing the competitive advantage of wheat with weeds. Preliminary results indicate an 8 percent yield advantage from ultranarrow rows over conventional seeding. Combine modifications allow the farmers to remove even grass weed seeds from the fields separately but at the same time as the wheat is harvested. Potential commercial uses for the weed seed will be investigated. Agricultural engineering continues development of new technology which will allow reducing the amount of pesticide and increasing applicator safety for conventional farming systems. Horticulturalists are developing systems which reduce the inputs necessary for commercial production of selected vegetables (Roberts and Cartwright 1990). Cocropping, living mulches, interplanting and IPM are some of the systems being studied. Educational efforts, thus far, have emphasized relating concepts to our various publics with demonstrations concerning best management practices (a natural tie from LISA to water quality) being considered for the upcoming year.

ACCOMPLISHMENTS

1. Integrated Pest Management (IPM)

   The Oklahoma Integrated Pest Management (IPM) program has made significant impacts in sustainable agriculture throughout the state on cotton, alfalfa, stored grain, wheat, soybeans, peanuts, livestock and urban audiences.

   IPM is a philosophy that has evolved over time and has become a prevalent philosophy among many Oklahoma farmers. It is not an entirely new philosophy but a philosophy that has evolved out of necessity to balance the economic, production, and environmental concerns.

   Integrated Pest Management is a systemic concept of crop protection which utilizes increased information and improved decision making to reduce off-farm inputs as a means of improving economic, social and environmental conditions.

   It replaces management for off-farm inputs including pesticides, fertilizers, and other inputs. The concept emphasizes integration of disciplines, pest suppression tactics, and concepts in economic and environmental management. Pest components include insects, weeds, plant parasitic nematodes, diseases, and other organisms which compete with man.

   The cropping system is the management unit is a process where decisions are made in a planned effective fashion to ensure favorable economic, environmental, and ecological consequence.

   Oklahoma IPM programs have shown significant decreases in pesticide and fertilizer inputs while maintaining or increasing potential profitability of the crop/livestock unit. Examples include a 66

percent reduction in pesticide in grain storage, up to a 50 percent reduction in pesticide use in alfalfa while increasing productivity by 33 percent and stand longevity by 1+ years. The Oklahoma IPM programs provide the forum to combine and balance, economic, production, ecological, environmental and food safety issues. The concept of IPM provides the balance to allow production agriculture continue to exist economically with minimal environmental threat.

2. Cultural Weed Control for Small Grains

Substitution of Cultural Practices for Herbicide to Control Annual Ryegrass and Cheat in Small Grain (Agricultural Engineering, Agronomy, Agricultural Economics). A combine has been "re" modified to collect chaff flow and transport the material into a trailing silage wagon. The combine has been prepared to begin harvesting on farms of cooperators in late May. An ultranarrow row (3") grain drill has been "re" designed to enable improved trash flow at higher speeds. It will be used on farms of cooperators this fall.

3. Organic Pest Control for Vegetables

The efficacy of a variety of "remedies" including vegetable oil, mineral oil, and Epsom salts have been evaluated for control of vegetable pests. For example, vegetable oil has been used to control corn earworms. (Entomology, Horticulture)

4. Arkansas-Oklahoma Sustainable Agriculture Network

A newsletter is produced and distributed. This component of the project is coordinated by Winrock International Institute for Agricultural Development, Route 3, Box 376, Petit Jean Mountain, Morrilton, AR, 72110, (501)727-5435.

Plans are underway to conduct a Sustainable Agriculture Conference on November 2-3, 1990. The conference consists of a field day at the Kerr Center for Sustainable Agriculture, at Poteau, Oklahoma. The remainder of the Sustainable Agriculture Conference will be held in Tulsa on November 3. Contact Dr. Ray Campbell, Division of Agriculture, Oklahoma State University, Stillwater, OK 74078 (405)744-6550.

5. Farm Decision Support System

Work has begun to generate information regarding Oklahoma production systems that can be incorporated into the national data base. This is part of the LISA/FDSS project which is being conducted by John Ikerd at Missouri.

6. Ag Chem

Agricultural Chemical Impact Evaluation and Management (Agricultural Economics, Agronomy, Agricultural Engineering, Forestry). One objective of Ag CHEM is to develop tools for analyzing potential impacts of agricultural chemicals on ground water quality and potential economic and environmental impacts of different regulatory scenarios regarding agricultural chemicals. One component is a model which simulates movement of chemicals through soil profiles. A weather model based upon 100 years of data from various locations across the state is another component. One objective is to interface the weather model, chemical movement model, and economic analysis model.

7. Diffusion and Adoption of Alternative Farming Approaches (Agricultural Education).

Two surveys were conducted and another survey is planned. The objective was to determine the interest, involvement, and perceptions of production alternatives.

8. The Kerr Center for Sustainable Agriculture continues to prepare and distribute a monthly newsletter. For information contact KCSA, P.O. Box 588, Poteau, OK 74953 (918)647-9123.

FUTURE/OUTLOOK

Continue emphasis on reducing inputs for natural resource management (eg. substitution of herbicide use with prescribed burning for range improvement; natural regeneration in timber production); initiate demonstrations on the Eastern Research Station based on legume-forage mixtures with concomitant reductions in fertilizer use; continue to refine equipment and procedures for leading competitive advantage to selected crops to reduce herbicide use; develop computer-assisted decision aids for planning optimal cropping systems; and others.

"Sustainability and Stewardship: Challenges for Agriculture" is the theme for a field day and educational conference on November 2-3, 1990. A field day is scheduled for Friday, November 2 at the Kerr Center for Sustainable Agriculture in Poteau, Oklahoma. The conference will be held at the Tulsa Junior College Northeast Campus on Saturday, November 3. Co-sponsors are Oklahoma State University, The Kerr Center for Sustainable Agriculture, and the Oklahoma-Arkansas Sustainable Agriculture Network.

Published Materials Developed Specifically for Sustainable Agriculture

Epplin, F.M. 198. Sustainable agriculture: Issues and implications. pp. 17-33 in Current Farm Economics. 62 (3). 51 pp. Dept. Agr. Econ., Agr. Exp. Stn., Okla. State Univ., Stillwater.

Roberts, B.W. and B. Cartwright. 1990. A reduced input approach to cabbage production: Managing erosion, fertility and pests. Okla. Agr. Exp. Stn. P-911. 15 pp.

PENNSYLVANIA

OVERVIEW

Sustainable agriculture is the production of food and fiber using an integrated system that increases the productive capacity of the natural and biological resources, while earning adequate profits for farmers, providing consumers wholesome, safe food, and minimizing adverse impacts on the environment (National Research Council, 1989). This complex system approach to the next generation of agricultural practices is rapidly evolving within both the scientific and farming communities of Pennsylvania, with extension squarely in the middle. The role of extension has been undergoing an accelerated transformation in recent years, especially with respect to the development and delivery of new tools for integrated pest management that may well serve as a model for the approach of other aspects of achieving sustainable agricultural production (Allen and Rajotte, 1990). Several programs within our state have evolved with the common goal of developing and adopting alternative agricultural practices that will produce minimal environmental impact while allowing efficient production on the farm. These programs are listed with a brief description of their scope and linkages.

CMA-PSU-ASCS -- The Crop Management Associations (CMA) have been organized and directed by PA farmers since 1979. Together with Penn State Cooperative Extension personnel (PSU) and the Agricultural Stabilization and Conservation Service (ASCS), an active cost share trial program is underway to reduce chemical use in dairy and other farming operations throughout the state. Currently, 29 of our 67 counties have CMA's with the ASCS trial program being conducted in 13 counties. Penn State-Rodale Institute have been conducting collaborative research projects and demonstration plots for a number of years. Cooperative projects involving new techniques for integrated pest management in apples, corn, forage, and potatoes, as well as defining policies for sustainable agriculture are being actively pursued. Penn State Expert System Development is underway by research and extension multi-disciplinary teams cooperating with growers/producers. Currently, expert systems are in development for all of our major crops and for several aspects of animal production important in Pennsylvania agriculture. Expert systems are being used to manage vast quantities of information and together with timely data inputs for specific locations can be used to aid in grower decisions, thus using more accurate information to reduce both the risks associated with decisions and also the amounts of chemicals used.

Pennsylvania Department of Agriculture (PDA) - Penn State linkages have been greatly expanded over the last 2 years with $3 million research funding made available through the PDA on a competitive basis for agricultural scientists throughout the state. The evaluation of these projects during the funding cycle involves both scientific and organized interest groups inputs on the relevance and importance of the anticipated results. Many projects on integrated pest management, water quality, nutrient management, and alternative agricultural practices are currently being funded under this cooperative approach. Most of these projects involve both extension and research teams cooperating with agricultural producers to evaluate the impact of proposed new practices. Penn State College of Agriculture extension-research interdisciplinary committees on Sustainable Agriculture, Water Quality, Natural Resources, Integrated Crop Management, Integrated Animal Production, and Food Safety have been organized. The goals of these committees are to identify and analyze needs, define appropriate strategies, recommend mechanisms for implementation, and communicate this information to local, state and Federal agencies and interest groups. Unique features of sustainable agriculture in Pennsylvania nutrient management and research has a long history in Pennsylvania agriculture (Lanyon, 1990). Current focus is on the development and validation of FIFO, a Field and Farm Technical Information management system that can provide a structure systems approach to aid in decisions for managing soil nitrates, and reduce ground water contamination. This work is being conducted through Penn State's Agronomy department, with several cooperating farmers. Extension personnel in the Nutrient Management Extension Education Program have been involved in providing Nutrient Management workshops and computer training throughout the state and in the development of rapid N soil testing kits to be distributed through county offices.

A cooperative program with the Penn Dept. of Environmental Resources has developed a computerized version of a Manual for Field Application of Manure for distribution to Conservation Districts, Township

Planning groups, and others. The development of expert systems in the major crops and animal production systems of Pennsylvania is being actively pursued among extension-research scientists and members of the College of Agriculture's Artificial Intelligence Laboratory. This approach involves multi-disciplinary teams and growers/producers cooperating to develop electronic decision support systems that provide an organized and structured system for incorporating scientific information from agricultural specialists together with the experiential information from successful growers/producers and timely inputs from the system to be managed during the season. This development comes at a time when the complexity of agricultural decisionmaking is rapidly increasing, and approaching the limits of any one individual to accomplish the task. Cooperation among a large number of individuals is thus required and represents a new approach to extension technology transfer (Rajotte and Bowser, 1990).

The overlapping interests of the Rodale Institute and Penn State in specific aspects of sustainable agriculture are continuing to develop and represent a local consortium of expertise with regional significance. The historical involvement of the Rodale Institute in promoting the benefits of sustainable practices and the long term involvement of Penn State in developing new integrated pest management tactics have been merging in the form of several cooperative projects. Research strengths exist in both locations, and the demonstration plots at Rodale, together with the county-based Cooperative Extension System, offer a strong two dimensional educational and technology transfer system for the agriculture of Pennsylvania and the region.

A special issue of the Journal of Soil and Water Conservation was devoted to "Rural Groundwater Quality Management: Emerging Issues and Public Policy Policies for the 1990's" and was a product of the Groundwater Policy Education Project (GPEP). This project is a joint effort of the Cooperative Extension, Freshwater Foundation, and Soil and Water Conservation Society. The project is funded by the Kellogg Foundation in cooperation with the Farm Foundation. Materials developed by the GPEP including the special issue and leaflets on groundwater management and policy, will be used in educational programs in Pennsylvania and six other states over the next year and a half. Penn State Cooperative Extension and the League of Women Voters of Pennsylvania are working together on this project. Charles Abdalla is the Chairperson, Groundwater Policy Education Project, Department of Agricultural Economics and Rural Sociology.

ACCOMPLISHMENTS

Crop Management Associations (CMA's)

Crop Management Associations are organized and directed by farmers. Farmers charge themselves acreage fees and hire crop management personnel to scout crops, document observations, make management recommendations and assist in developing sound crop management plans. The first association was organized in Pennsylvania in 1979. Currently, CMA's are operating in 29 of Pennsylvania's 67 counties. Approximately 80,000 acres have been enrolled by 450 members. Ninety-six percent of CMA members are dairy farmers. Originally, farmers joined CMA's mainly because they lacked the time required to collect and document site-specific information necessary to determine if and when pest controls were necessary. CMA farmers hired scouts who took soil samples and counted crop pests. Gradually, members recognized they lack not only the time but the technical expertise required to formulate a profitable and environmentally sound integrated crop management system. CMA's now employ technically skilled personnel who make recommendations and assist in developing integrated crop management systems.

Since 1979, Penn State has provided four basic categories of support to CMA's: organizational and technical support offered by local extension agents; technical training offered by extension specialists and the crop management coordinator (these include conservation, insect, nutrient and weed management workshops and computer training); educational support materials such as fact sheets, monthly newsletters and weekly crop pest reports; and a crop management recordkeeping/computerized database system for documenting and managing field-specific information.

In 1990, USDA/ASCS recognized CMA's as a valuable tool for implementing cropping systems that sustain the farm and the environment. To encourage the adoption of ICM systems that incorporate

conservation, IPM and nutrient management, ASCS implemented a pilot Integrated Crop Management cost-share program modelled after the CMA program in Pennsylvania. ASCS will assist growers pay for services delivered by crop management consultants by funding up to $7 per acre for agronomic crops and $14 per acre for fruit, vegetable and specialty crops. Cost-sharing is designated for a maximum of 5 counties per State and 20 farms per county, except in Pennsylvania where 6 areas encompassing 13 counties have been designated for cost-sharing. Penn State and CMA's have been partners in promoting sound crop management since 1979. As a new partner, ASCS provides an initial economic incentive to farmers to participate in CMA programs that promote the adoption of ICM systems (Jan Pruss, Coordinator, PA Crop Management Association).

Expert Systems

An expert system known as the Penn State Orchard Consultant (PSOC) has been developed to help apple growers make better decisions about production and pest management. After 4 years of development and testing (including 2 years supported in part by a LISA grant), this system has recently been made available for sale to fruit growers in Pennsylvania through Penn State Cooperative Extension (Travis et.al., 1990). The system integrates various facets of apple production. It gives the apple grower the information necessary to reduce some purchased inputs by substituting high quality, integrated, information derived from three sources (state-of-the-art apple production and IPM knowledge; site specific, farm level data; and weather records). A primary emphasis of the PSOC expert system is to decrease the detrimental environmental impacts associated with pesticide and fertilizer use as well as input costs, thereby improving farm profitability and reducing economic risk (Rajotte, E. G. and T. Bowser, 1990).

Nutrient Management

In the nutrient management area, 54 workshops were held with a total attendance of 2,744 individuals. Scores on a pre-post test improved an average of 61 percent following workshops. As a result of this program, 500 nutrient management plans were developed and 250 nutrient management plans implemented. Based on current research results a major educational program on soil nitrate testing to better match nitrogen applications to soil and crop needs and thus reduce nitrate pollution potential was conducted. A field test kit was developed, 110 extension agents and related personnel received in-service training, farmer education materials and programs were developed, and consequently over 1,400 soil nitrate tests were run in an evaluation and demonstration program on nitrate soil testing.

Chesapeake Bay

Penn State's involvement in the Chesapeake Bay Program led to the development of a comprehensive approach to farm nutrient management for reducing agricultural NPS (non-point-source) pollution. Previously, manure from intensive poultry and livestock operations was regarded as a waste product with little thought given to its proper disposal. On sites where large amounts of manure were deposited, the quality of associated surface and ground water resources often declined.

Nutrient management involved budgeting for the nutrients contained in the manure and programming the application of these and other nutrient sources to achieve crop yield goals while minimizing the application of excessive amounts and the resultant nitrate or phosphate pollution of adjacent water resources. Recent introduction of the new PSNT (Pre-sidedress Soil Nitrate Test) has provided farmers with an added capability for implementing effective nutrient management programs that reduce both costs and pollution associated with nitrogen fertilizer use (Al Turgeon, Head, Department of Agronomy).

Pesticide Education

Penn State's Pesticide Education Program provides educational support for virtually all areas of importance to pesticide applicators, including pest management, chemical handling, human health and safety, and environmental quality. The form of this educational support can vary widely but includes travel and production support for pest management specialists, agrichemical fact sheets and publications, instructional slide sets and videotapes, and hands-on demonstrations by our staff. A majority of our

time and effort is devoted to the support of the EPA's and the PA Department of Agriculture's Pesticide Applicator Training program, which trains and certifies applicators in the handling of Restricted Use Pesticides (Scott Harrison, Coordinator, Pesticide Education).

FUTURE/OUTLOOK

Crop Management Associations

An Integrated Crop Management (ICM) system requires farmers to establish a system for managing information. Currently, at Penn State a recordkeeping/computerized database system has been developed for organizing field-specific information to generate field, crop and farm-specific reports on crop inputs utilized, soil nutrient levels, field activities accomplished and the cost of crop production. Organized records provide farmers with historic data necessary for evaluating management practices. In addition to providing farmers with a system of managing information, the computerized database system allows researchers at Penn State to aggregate data and thus develop baseline information on cropping practices by county, region or state. In the future, all CMA farmers will be encouraged to implement the Technology Information Management System. Penn State will continue to provide CMA's with organizational, technical and educational support. With the ICM cost-share incentive provided by ASCS, farmer membership in CMA's will increase. Almost one-half of Pennsylvania's counties are affiliated with CMA's. Penn State will work towards establishing CMA affiliation in every county (Jan Pruss).

Expert Systems

Agricultural production has evolved into a complex business requiring the accumulation and integration of knowledge and information from many diverse sources including marketing, horticulture, insect management, disease management, weed management, accounting, and tax laws. Increasingly, the modern grower must become expert in the acquisition of information for decisionmaking in order to remain competitive. However, integrating and interpreting information from many sources may be beyond the means of individual growers so they use the expertise of agricultural specialists. No organized structure is presently available for information storage and retrieval, consequently, technical information, both experimental and experiential, is often lost or unavailable to potential users. One way to make this information readily available is through the use of electronic decision support systems. The development of an electronic decisions support system requires the combined efforts of growers who will use them (Rajotte, E. G. and T. Bowser 1990).

Chesapeake Bay

Nutrient management is only one aspect of integrated crop management (ICM). Opportunities are unfolding for incorporating different aspects of crop management into a single, interlocking, user-friendly management system that will be of enormous value for improving the competitiveness and profitability of U.S. agriculture while minimizing the adverse environmental consequences sometimes associated with farm operations (Al Turgeon).

Pesticide Education

Many of our educational activities provide valuable information directly related to the sustainable agriculture concept. In particular, our efforts in the areas of Integrated Pest Management, Endangered Species Protection, and Water Quality and Protection contribute significantly to the knowledge base of individuals desiring to promote sustainable agriculture practices. In short, we support the prudent and safe use of pesticides, a concept that is in harmony with the principles of sustainable agriculture (Scott Harrison).

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Authors

1. Dr. James L. Frazier, Head, Department of Entomology and Chair of the College of Agriculture Sustainable Agriculture Research and Extension Committee.

2. Dr. Donald E. Evans, Assistant Dean, College of Agriculture, Assistant Director, Penn State Cooperative Extension.

TENNESSEE

OVERVIEW

Sustainable agriculture is based on several general approaches aimed at reducing environmental contamination, conserving resources, and providing an adequate and dependable farm income. A sustainable agriculture is one which is productive, competitive and profitable.

A variety of Agricultural Extension Service educational programs directly address sustainable agriculture and natural resource issues in Tennessee. The programs include but are not limited to integrated pest management, soil fertility, conservation tillage, water quality and erosion control whole farm demonstrations, financial management and forestry demonstrations. Sustainability concepts have been incorporated into our educational program plans, publications, videos, meetings and training programs. Three interdisciplinary teams concerned with sustainable agriculture, alternative agricultural opportunities, and water quality coordinate and enhance our educational programs in these critical areas. About every agriculture discipline is represented on these teams. A number of sustainable agriculture programs in Tennessee involve the Tennessee Valley Authority and other professional agencies, as well as several hundred cooperating demonstration farms.

ACCOMPLISHMENTS

Apple Study Reduces Pesticide Use In Tennessee

A pilot program for apple integrated pest management (IPM) was conducted in several orchards across the state. The program consisted of scouting 25-acre blocks of apples each week in three regions of the state. Using economic thresholds for the insects, producers were able to determine whether treatments needed to be applied. The results of the pilot study showed that blocks of an orchard managed under the IPM program received two to five fewer sprays than blocks receiving routine cover sprays. In addition, an average savings of three miticide applications was realized by using IPM. This translated into chemical costs savings of $340-$1450.

Improved Quality of Tennessee Dogwood Trees

The dogwood borer is the most serious insect pest of dogwoods grown in commercial nurseries and in the landscape. Routine preventative sprays have been applied to control this pest in the past. Demonstrations for control of dogwood borers were conducted during the last 2 years in commercial nurseries. Excellent control of the dogwood borer was seen in all tests over the 2-year period. The number of insecticide sprays and the amount of active ingredients applied was reduced while the quality of dogwood seedlings was improved.

Tennessee Strawberry Growers Increase Profits and Reduce Disease Losses By Altering Cultural Practices

A serious disease called crown anthracnose struck several of Tennessee's strawberry fields in 1987. Extension staff advised producers not to do anything about the disease; not to spray, not to cultivate, not to replant the entire field and not to abandon the field. Replanting the skips (dead plants) the following spring should be the only necessary action. Just as predicted, none of 1987's diseased fields had any anthracnose in 1988; the fungus had died. Many dollars in expenses and unnecessary pesticides had been avoided. By following the advice of the Agricultural Extension Service staff, approximately $300,000 had been saved.

Cotton Grower Pest Management Schools In Tennessee Reduce Pesticide Use

Tennessee's cotton insect pest problems have increased over the past few years. A scout training school was held in May 1989 and 1990 to train cotton scouts. Eighty-nine scouts, farmers and private consultants participated in this training in 1989, and 129 participated in 1990. From 1985 to 1989, 667 cotton grower contacts were made in 18 cotton-growing counties in West and Middle Tennessee.

Growers were advised to properly identify and monitor pest problems, to apply pesticides where and when needed and to choose correct pesticides and rates of use. Results included reduced cost of cotton production and reduced environmental contamination.

Profitability Of Tomato Integrated Pest Management In Tennessee

The Extension Service conducted a tomato scouting school for interested tomato growers in Tennessee. Nine scouts were trained. The tomato IPM program has reduced pesticide usage. It has been demonstrated that up to 16 insecticide applications may be saved each season. This represents a considerable amount of savings (improved profitability) to the tomato growers, reduced environmental contamination and delayed pest resistance to pesticides.

Tennessee Wildlife and Forestry Production Programs

Educational programs were delivered to landowners concerned with the conversion of marginal lands from agricultural production to forest cover. Assistance included planning, securing planting stock and management services, timber inventory, marketing and selling of timber products. The purpose was to provide landowners an additional source of income from these lands. Emphasis was placed on integration of natural resources and agricultural enterprises for management purposes. A program in wood utilization strengthened local small and medium sized primary and secondary wood processing industries. This was important to sustainable agriculture by providing local, viable markets for timber products produced on private lands.

Development of Enterprise Budgets for Alternative Agricultural Enterprises

Considerable efforts have been placed on developing economic information to assist farmers in diversifying their current farming operations. Detailed budgets for 42 different fruit and vegetable crops were developed along with budgets for edible and industrial rapeseed, container and field-grown nursery stock, greenhouse crops and black walnut and white pine forest plantations. These budgets were used extensively by Extension agents and specialists in group meetings and in planning sustainable agriculture systems with farm families.

Economic Level of Johnsongrass Control in Tennessee Soybeans

Johnsongrass is the primary late season pest affecting soybean production in Tennessee. A study was conducted to determine maximum economic expenditures for johnsongrass control for varying levels of infestation. The information was summarized into an easy-to-use publication. Farmers can simply count their level of infestation, and given their expectations for soybean prices, determine the maximum amount they should spend for johnsongrass control herbicides. This type of information should greatly reduce over application of these pesticides.

Conservation Tillage in Tennessee

A major effort has been made to encourage adoption of conservation tillage for major row crops. The objectives of this effort were to sustain the soil resource base through reduced erosion, to protect water quality in streams and lakes, and to maintain or increase producer income through improved yields and/or reduced expenses. In 1989, the Tennessee Agricultural Statistics Service reported that conservation tillage was used on 26 percent of the soybean acres, 21 percent of the corn acres, and 15 percent of the grain sorghum acres in the state. The Conservation Technology Information Center reported that 32 percent of newly-established pastures in Tennessee were established using no-till.

Tennessee Soil Fertility Educational Program Paves the Way For Sustainable Agriculture

Soil fertility educational efforts have dealt with promoting soil testing and encouraging efficient N use. Fertilizer recommendations from the Soil Testing Laboratory have been revised to make use of alternative N sources. For example, the amount of N recommended for either corn, tobacco or grain sorghum was reduced by 50-80 pounds per acre when the crops follow a winter cover of crimson

clover or vetch. For the period 1986-1989, over 15,000 growers were provided the above recommendations. During the same period, 6,810 growers were encouraged through soil testing to not apply N to soybeans.

Educational Programs in Tennessee Tree Fruits and Grapes

Extension educational programs have placed increased emphasis on fitting an overall management program together to maximize fruit yields and quality while minimizing inputs of materials such as pesticides and fertilizers. Management of ground cover in orchard has been effective in reducing pest pressure on trees. Implementation of an "alternate row middle" spray program in apple and peach orchards in selected demonstration has enabled growers to reduce pesticide applications by 1 to 1-1/2 total sprays. The overall effects of these efforts were more efficient and safe use of pesticides as well as achieving increased consistency in crop yields and quality.

Sustainable Agriculture Programs in Tennessee For Commercial Vegetable Production

Commercial vegetable production programs have focused on practices that reduced the overall amounts of chemicals or fertilizers applied while maintaining sustainable economical yields. Excessive fertilizer applications are a common practice with several tomato growers. With one 60-acre tomato grower, it was demonstrated that using recommended fertilizer applications would increase gross return by $75 for each dollar spent on fertilizer while reducing the rates being used by the farmer by 37 percent. In one demonstration on tomatoes, insect control was increased by 82 percent from a change in sprayer design only. This also resulted in a reduction in the number of applications by 1/4 and approximately a 15 percent increase in marketable yield.

Quality of Groundwater on Tennessee Poultry Farms

There are approximately 125 million broilers grown on more than 800 Tennessee poultry farms. In most cases, the poultry manure is utilized as a fertilizer on pasture, small grain or row crops. A well water and soil testing survey is currently underway to determine what effect, if any, the use of poultry manure as a fertilizer is having on ground and surface water on Tennessee farms. Preliminary results indicate there are no serious nitrate problems. However, coliform bacteria could be a problem in some wells. The final study will be used to determine the quality of water on poultry farms and to develop educational materials related to managing poultry waste and reducing the potential for water contamination.

Tennessee Resource Management Conservation Whole Farm Demonstration Program

Approximately 80 Resource Management Conservation (RMC) farm demonstrations are active in showing that farm profitability can be maintained while reducing soil erosion and improving water quality. Data from these demonstrations show that when the crop and livestock plans were implemented, income increased and soil loss was reduced. A study of 264 farms which completed the program from 1979-89 indicated farmers were losing an average of 9.7 tons of soil per acre before enrolling in the RMC program. Soil Conservation Service personnel estimated they could lower this loss to 2.9 tons per acre. This estimate is in line with another study of what was actually achieved on a group of 51 farms. They started with an average annual soil loss of 7.8 tons per acre and they reduced the loss to 2.7 tons at the end of 6 years.

FUTURE/OUTLOOK

Tennessee farm families are extremely aware and concerned about sustainable agriculture issues. There will be some farmer reluctance to adopt some proven sustainable practices. Growers are often slow to make major changes in production practices. A comprehensive and expanded demonstration program will be implemented to show farmers sustainable practices, how they can be implemented and how the practices or system will have a favorable economic impact on their operation over a reasonably short period of time. These whole farm demonstrations will be for both other farmers and technical agricultural workers. These farms will demonstrate ways to improve the total economic well-being of farm families and the quality of our natural resources.

VIRGINIA
Virginia Polytechnic Institute

OVERVIEW

During the past decade increasing concerns for the economic viability and ecological sustainability of agriculture have produced an accelerated search for alternative farming systems. The concept of sustainable agriculture has emerged which addresses multiple objectives: increasing agricultural profitability, minimizing undesirable environmental impacts from farming, conserving energy and natural resources, and fostering a safe and healthy food supply. Both long and short term goals are considered, as well as farmer and societal interests. Economic and environmental sustainability becomes a criteria to evaluate the appropriateness of both farm practices and public policy. Sustainable agriculture is thus a goal to be worked towards, a philosophy, and a constantly evolving system of farming practices and public policies.

Because of documented as well as perceived problems associated with the use of agricultural chemicals in modern agriculture, considerable attention has been focused on approaches to reduce the need for these inputs. The term low-input has evolved which implies a reduction of external production inputs (i.e., off-farm resources such as fertilizers, pesticides, and fuels). Emphasis is placed on optimizing the management and use of on-farm, renewable resources to minimize reliance on off-farm, purchased inputs. Like sustainability, low-input is a relative term lacking in precise definition, but forms a framework to examine specific farming practices and systems. A fundamental assumption underlying the sustainable agriculture concept is that farming systems can be redesigned to better utilize naturally-occurring beneficial ecological processes such as nitrogen fixation, nutrient cycling, allelopathy, and biological pest control.

In Virginia, sustainable agriculture programs have focused on two main areas: (1) expanding the research base on more sustainable farming practices and systems, and (2) developing educational programs on sustainable agricultural practices and systems for farmers, and extension and agribusiness professionals. It should be emphasized here that many on-going educational programs by the Virginia Cooperative Extension Service, the Soil Conservation Service, the Virginia Department of Agriculture and Consumer Services, and other state and federal agencies contribute directly to these objectives. Likewise, many research programs at Virginia Polytechnic Institute & State University and Virginia State University have been and are continuing to expand the knowledge base for a more sustainable agriculture, even though these educational and research programs do not carry the "sustainable agriculture" label.

For example, a large scale education and demonstration project by Virginia Cooperative Extension Service and the Virginia Division of Soil and Water Conservation has focused on more efficient use of animal manures for crop fertilization. This project has had a dramatic impact throughout the state in terms of reducing chemical fertilizer use and reducing groundwater and surface water contamination by animal wastes. This "nutrient management" program contributes directly toward the goals of a more sustainable agriculture, yet this program operates quite independently of any designated "sustainable agriculture" program. Many other programs like this exist, such as statewide Integrated Pest Management (IPM) programs, but to summarize them all is beyond the scope of this report.

Therefore, the following report on sustainable agriculture program activities in Virginia relate to specific research and educational activities conducted since 1986 under the auspices of the Virginia Tech Sustainable Agriculture Program. An interdisciplinary, inter-agency advisory committee was formed in 1986 to generate new ideas for expanding Extension Service activities relating to sustainable agriculture and to foster new research projects. An interdisciplinary research/extension group formed in 1988 to develop a project funded by the USDA Low Input Sustainable Agriculture Program.

ACCOMPLISHMENTS

Establishment of a Long-Term, Crop-Livestock Systems Comparisons Study

A farm scale (80 acre, 48 cattle) experiment was established in 1988 at the VPI&SU research farm to compare a conventional crop livestock system typical of the mid-Appalachian region with an experimental low-input system. This is a replicated experiment (4 replications of 10 acres each for each system) intended to be in place at least 10 years. Crops grown in these systems include fescue, red clover, alfalfa, corn, wheat, and millet. Steers will graze forages grown within each system and be fed other harvested feed from each system. Animal health and performance will be monitored. Total system economics will be evaluated, as well as long term systems effects on soil parameters and insect and weed populations. Faculty members and graduate students from six academic departments are involved in this study.

Development of Low-Input Corn Production System

Several on-farm research/demonstration projects have been conducted to evaluate various components of a low-input corn production system. In a two year study, corn grown following winter annual legumes without any additional N fertilizer produced equivalent corn silage yields to corn grown without legume cover crops plus 125 lbs N/acre. In another project, mowing winter rye cover crops was compared to conventional desiccation with paraquat herbicide for no-till corn production. In five on-farm studies, the mowing treatment produced an average net benefit of approximately $40/acre more than using the herbicide. In a third study, now in the second year, a ridge-till corn production utilizing mowed winter annual rye/vetch cover crops has been developed to evaluate low-input weed control practices. Herbicide requirements have been reduced by more that 75% in this study. Several Extension-sponsored field days have been conducted at these sites to communicate research findings to farmers.

Expert System Development for Planning Whole Farm Crop Rotations

A prototype computer-aided decision making system called CROPS (Crop Rotation Planning System) has been developed for farm-level planning. This program uses artificial intelligence techniques to generate crop rotation plans for individual farms, implementing low-input sustainable practices and comparing these plans with conventional alternatives. It answers a fundamental need in the pursuit of a sustainable agriculture because it is impossible to implement low-input sustainable practices without addressing the whole-farm planning problem. Planning crop rotations involves or influences (1) the entire acreage of the farm, (2) tillage and soil conservation plans, (3) pest management, (4) use and purchase of fertilizers and lime, (5) farm economics, (6) farm diversification, and (7) livestock requirements and operation.

CROPS is now under further development, having received additional financial support from the 1990 USDA LISA program. The final version will not only generate crop rotation plans that implement low-input practices, it will also analyze the plans generated and allow the farmer-user to compare the generated plans with alternatives. The system will include simulation models for estimating soil erosion and for analyzing the financial status of the farm under various alternative combinations of crop mixes, farm program participation, and machinery complement.

Extension Educational Programs

Several educational programs for farmers, extension, and agribusiness personnel were conducted through the Virginia Cooperative Extension Service to provide practical information on sustainable farming practices and systems. These included the following:

1. A 1-day training session on sustainable agricultural systems was held for extension agents as part of their annual in-service training. Extension agents learned new low-input practices that can be used across a wide array of cropping systems, as well as additional sources of information to serve interested clientele.

2. The statewide Virginia Conference on Sustainable Agricultural Systems, March 13-14, 1989, in Charlottesville was cosponsored by the Virginia Cooperative Extension Service, the Virginia State Horticultural Society, and the Virginia Division of Soil and Water Conservation.

3. A multicounty farmer educational meeting on sustainable agriculture in Amelia County was cosponsored by the Virginia Cooperative Extension Service and the Virginia Farm Bureau Federation. Multicounty grower meetings on sustainable agriculture were also conducted at two other locations in 1989.

4. A research update in-service training session on LISA projects for extension agents of the Virginia Cooperative Extension Service West-Central District was conducted by LISA project personnel.

5. A low-input sustainable agriculture field day in August, 1989, at the VPI&SU Agricultural Research Farm, Blacksburg, Va.

6. A statewide conference entitled "Farming for Profit and Stewardship" was held March 15-16, 1990, was cosponsored by Virginia Cooperative Extension Service, Virginia Department of Agriculture and Consumer Services, the Soil Conservation Service, and other groups.

FUTURE PERSPECTIVES

A fundamental change of production paradigm, from managing industrial inputs to managing ecological processes, is essential for the transition to a more environmentally sound, sustainable agriculture. Expansion and documentation of the scientific basis of agroecology and translation of this knowledge into site-specific, usable information form the challenge for agricultural researchers and educators. Also important is the acquisition, evaluation, and horizontal distribution of the indigenous, local knowledge that exists among farmers.

Considerable disagreement exists, however, among researchers and Extension personnel concerning the goals and practices of sustainable agriculture. Some see sustainable agriculture as a thinly-veiled form of organic farming; others see it as merely another term for "best management practices" they've been researching and promoting already. Many farmers and agribusiness people are resistant to any philosophy that involves a reduction in the use of agricultural chemicals. Continued dialogue will be required to clarify misunderstandings of the goals and approaches needed to move towards a more sustainable agriculture.

From an Extension perspective, the Virginia Sustainable Agriculture Program will focus on expanded on-farm demonstrations and field days to communicate practical methods of farming for both profitability and land stewardship. Developing relatively long-term, whole farm systems demonstrations will be necessary to communicate the potential long-term benefits of integrated systems.

VIRGINIA
Virginia State University

OVERVIEW

The mission of the Agricultural component of the Cooperative Extension Service at Virginia State University is to provide educational programs that improve the quality of life of all Virginian landowners but focuses on small and part-time farmers and landowners with limited resources. The general philosophy that guides these educational programs is that small-scale agriculture systems are much more sustainable in both environmental and economic respects than large-scale agriculture systems.

Program Infrastructure

The Sustainable Agriculture Program focuses on organic food production, diversification and Water Quality. The program is implemented through multi-disciplinary teams of Extension Specialists, researchers and program aides. Leadership for the program is provided by the Assistant Extension Administrator for Programs.

ACCOMPLISHMENTS

Organic Food

The Extension Program provides demonstrations, publications and seminars across Virginia in organic food production. This is not reduced use of chemical fertilizers and pesticides. This program advocates absolutely no use of synthetic inputs in the production of livestock, grain crops, forestry crops, fruits and vegetables.

Organic food production systems are necessarily small in scale and are imminently sustainable. There is no soil erosion. No herbicides are dripping into groundwater reservoirs. The consumer market demand for "certified organic" beef, poultry, eggs, fruit, vegetables, grains and even tobacco is strong. An extremely enthusiastic audience of small and part-time farmers who want to discontinue using synthetic chemicals help plan, promote, implement and evaluate these programs.

Diversification

Agriculture diversification as it relates to small, part-time and limited resource landowners is another strong component of our Sustainable Agriculture Program. The Cooperative Extension Service at Virginia State University provides information on the commercial production and marketing of the following crops and livestock products:

Royal Paulownia Trees
Hybrid Striped Bass
Culinary Herbs
Oriental Vegetables
Meat-type Goats

Organically Grown Produce
Organic Beef
Goldenseal
Oyster Mushrooms
Elephant Garlic

American Ginseng
Ostriches
Vietnamese Potbellied Pigs
Angora Goats for Mohair
Everlasting Flowers

Range Poultry
High-Density Apple Orchard

Channel Catfish
Freshwater Shrimp
Rainbow Trout
Crayfish

Medicinal Herbs
Aromatic Herbs

Thornless Blackberries
Table Grapes

Shiitake Mushrooms
Rabbits
Belgian Type Endive
Hydroponic Lettuce and Tomatoes
Snow Peas

Through development and support of grower associations such as Appalachian Mushrooms Growers, Mid-Atlantic Fish Farmers, Virginia Greenhouse Growers Association, Virginia Herb Growers and

Marketers Association and the Virginia Association of Biological Farmers, producers of new and speciality crops gain education, buying power and marketing power. Development of grower associations are a vital role of our Extension Service. Work within and among these producer associations consisted of 36,600 man hours at a cost of $183,000.

The Extension Service provides information through conferences, farm tours, economic budgets, publications and field demonstrations. Audiences are attracted to these educational programs from eight different states. Approximately 5,000 landowners in Virginia participate in our diversification programs.

Water Quality

The Water Quality Program assists limited resource farmers in obtaining information necessary to protect the quality of their water supply. Virginia State University has implemented a special information delivery system that has been successful in reaching Limited Resource audiences through the use of program aides.

The USDA Soil Conservation Service, and Extension Water Quality Program utilized 5 Program Aides in 10 Southside Virginia Counties. The program aides conducted 117 different meetings reaching 2,093 clientele in 18 different types of community groups or organizations. Eleven referrals of major problems were referred to the Soil Conservation Service by program aides in this 4-month intensive awareness programming effort. The program utilized a total of 2,500 man hours at a cost of $18,000.00. It has been shown through informal evaluation that the program has been successful and several local governing bodies have expressed an interest in the continuation of this type of program as well as various clientele.

FUTURE/OUTLOOK

The true barometer of our Sustainable programming effort will come later as we observe a change in practice by our clientele.

It should be noted that their is an increase in demand for Sustainable Agriculture Programming by key community leaders and local governmental officials. This is a positive indicator that Sustainable Agriculture and natural resource program will become mainstream.

WEST VIRGINIA

OVERVIEW

West Virginia's general Agricultural Program and Sustainable Agricultural Program has three basic generic objectives.

1. Ensure a profitable farming operation.

2. Protection of the environment during the production/processing/ marketing phases (water quality, air quality, soil conservation).

3. Producing a quality/nutritious food free from undesirable residues.

A basic group of programs focus on achieving those broad objectives.

- soil testing
- variety recommendations
- corn hybrid trials
- pesticide recommendations
- integrated pest management program
- integrated crop management program
- animal and crop waste management
- standards for applying municipal wastes to agricultural lands

ACCOMPLISHMENTS

West Virginia does not have much level land and as a consequence a good deal of emphasis is placed on pasture and forage crops. Programs on creep grazing, pasture rotation, intensive grazing, brush control, fencing, water development have contributed to improved pasture utilization for many years. More recently no-till seeding to improve species have been introduced and intensive grazing systems are being demonstrated on selected farms. All of these programs are directed at making livestock farms more efficient and competitive.

Another successful extension venture is the corn no-till program. In recent years, West Virginia has ranked in the top five states in the percentage of corn planted by no-till methods.

West Virginia Conservation Farmer Program integrates all of the above programs. This program seeks to identify annually the farm which best exemplifies the ideal conservation farming operation. To win, competing farms must be able to effectively integrate crops, pasture, livestock, and conservation into a successful Cooperating unit. Participants of this program serve as positive role models for other farms in their communities.

To highlight an accelerated extension concern for sustainability, a center for Sustainable and Alternative Agriculture has been designated. Several functions currently underway in the center are:

- development of a relevant resource library
- assisting the state in developing organic production certification standards
- pilot on-farm composting demonstrations
- direct communication with agents, producers, gardeners on pest management and nutrient alternatives
- assist in identifying needed research

WISCONSIN

OVERVIEW

Various definitions for sustainable agriculture have been proposed, but most included the components of profitability, resource protection, consumer product safety, and viability of rural America. Development of sustainable agriculture programs by the University of Wisconsin-Extension has resulted in the following working definition:

> "Agriculture is sustainable when the systems and strategies employed enhance or maintain the ability of agriculture to meet broadly defined human needs indefinitely within the context of profitability and competitiveness. These systems must function such that soil does not erode beyond its replacement rate. Water supplies must not be depleted or threatened. Pest control strategies must not further threaten endangered species or pose significant health hazards to farmers and their families, their neighbors, or consumers. These strategies must have long-term effectiveness and be adapted as pests and problems change. Therefore, sustainable agriculture is based on using best available management within the complexity and interdependency of natural systems. Sustainable agriculture cannot be confined to organic or low-input definitions. These (sustainable agriculture) systems are management-intensive, eco-sensitive, and people-oriented."

University of Wisconsin programs in sustainable agriculture are coordinated through two committees: 1) extension efforts are planned, coordinated, and executed by the Sustainable Farming Systems committee; and 2) research and teaching programs are developed and coordinated through the newly-formed Center for Integrated Agricultural Systems. The mission of the Center is to foster and support applied interdisciplinary research related to agricultural sustainability, including economic viability and resource protection. The Center will develop and coordinate research, outreach, training, and education programs to assist farmers as they implement practices to protect our state's water resources while retaining or increasing both farm profitability and the viability of rural communities. In addition, these programs will also address the important interrelationships among agricultural policies, rural economic development, environmental concerns, food quality, and farming systems. These efforts will be interdisciplinary in nature and will include work such as system evaluation of long-term crop rotations, livestock-pasture systems, watershed studies incorporating physical and socio-economic approaches, and studies of relationships of farm structure (number and type of farms) and rural communities. The Nutrient and Pest Management program is an Extension activity that is part of the Center. This program has placed regional specialists throughout the state and currently focuses on the development of best management practices for Wisconsin crops. The Center is funded at slightly less than $600,000 for the 1989-1991 biennium.

In addition, the Wisconsin Department of Agriculture, Trade and Consumer Protection (WDATCP) has operated a sustainable agriculture program since June 1987, focusing on various practices and technologies that reduce our dependence on specific purchased petroleum-based inputs. The program's basic purpose has been to fund and coordinate demonstration projects throughout the state in order to publicize and promote farm practices that demonstrate energy savings, environmental benefit, and farm profitability. Projects were selected and funded through a competitive grant system conducted with the help of a citizen advisory council.

To date, grant rounds have been completed with the funding of 77 projects at just over a total of $1.5 million. About half of the projects are headed by University of Wisconsin applied researchers and/or extension personnel. Subject matter of some of the projects includes:

- Pasture management and forages;
- Integrated pest management;
- Conservation tillage;
- Manure and nutrient management;
- Alternative crops and products;
- Farmers network development;

- o Whole-farm economic analysis;
- o Surveys on perceived and encountered barriers to reducing purchased chemical inputs.

ACCOMPLISHMENTS

Although topics emphasizing the efficient use of all agricultural resources have been integrated into multidisciplinary enterprise-oriented extension programs for many years, specific programs and activities using the title of sustainable agriculture have been conducted since 1987. Major efforts have included:

1. Conducting a series of conferences for individuals interested in sustainable agriculture and the practices commonly associated with the term (three in 1988 and six in 1990). These programs have emphasized research findings on the efficacy, applicability, economic viability, and potential limitations of various production methods and systems. In 1988, the meetings stressed existing research results, whereas in 1990 emphasis was placed on recent, on-going projects. A proceedings was provided to all attendees.

2. Very little written information has been available specifically identified as appropriate for those who identify with the term sustainable agriculture. Therefore, a series of Extension Fact Sheets was created under the overall heading of Management Guides for Sustainable Agriculture. To date, ten of these publications have been completed. Example titles include "Using cover crops in sustainable agriculture," "Field and forage crop disease control without chemicals," "Interpreting soil test results and recommendations in sustainable agriculture," "Nutrient crediting for manure," and "Managing insects in sustainable agriculture." About 2000 sets of this series have been distributed in Wisconsin, Iowa, Illinois, and Minnesota.

3. Substantial interest exists in alternative crops of many kinds. A loose-leaf notebook ("Alternative field crops manual") containing production, utilization, and marketing information on many alternative crops is being jointly created by Wisconsin and Minnesota. To date, about 15 chapters are complete (e.g., adzuki bean, amaranth, canola, flax, lupine, spelt), and another 30 or so are planned. Copies of the manual have been placed in the county extension offices of both states.

4. In 1989, the University of Wisconsin-Madison College of Agricultural and Life Sciences held "listening sessions" at five locations around the state, "to seek ideas and suggestions from interested citizens for future research and extension programs in sustainable agriculture and related areas." Although not restricted solely to discussion of sustainable agriculture, the meetings were oriented toward that farm approach. The underlying philosophy behind these meetings was to create an atmosphere where open discussion could occur without fear of someone criticizing or passing judgment on the suggestion. Toward that end, several steps were taken to establish as non-threatening environment as possible: (a) The meetings were not held in Madison; (b) Non-University moderators interested in, or identified with, sustainable agriculture led the group work sessions; (c) University participants were instructed to not try to rebut any proposed idea or to use the group sessions for teaching; (d) County faculty developed some individualized publicity for identified sustainable agriculture advocates in addition to traditional advertising. The primary activity was the group workshop sessions where all present attended two sessions to express their concerns and ideas on: soil management systems, animal management systems, resource (soil and water) protection, and socio-economic/community implications. At least two county and UW-Madison faculty were assigned to keep an accurate record of all suggestions, criticisms, or ideas generated. When completed, the discussion from each of these sessions was summarized for the whole meeting by a UW faculty member with the help of county extension faculty and the non-University session moderator. A proceedings that contained copies of the papers presented, individual workshop reports, a summary of ideas presented, and a list of all attendees was mailed to each of the participants after the last meeting.

Several broad trends for research and extension needs in sustainable agriculture surfaced: (a) the University should provide research and extension programs to help farmers through the conversion process to more sustainable systems; (b) research is needed on various practices and system alternatives such that informed decisions about specific practices can be made; (c) research mush be more holistic conceptually and examine policy and structural implications of various systems; (d) efforts in related basic research such as crop breeding for improved nutrient efficiency should be continued; (e) programs need to include more information on alternative nutrient and pest management systems; and (f) the impacts of various systems on the environment need to be delineated.

FUTURE/OUTLOOK

The recent attention on sustainable agriculture has had several clearly-identified benefits, including the increased attention associated with agricultural issues such as environmental impacts, food safety, family farm structure, and soil conservation. It has resulted in universities being able to demonstrate that they have been conducting applicable research and has resulted in new funding made available. Communication with more diverse audience groups has improved, and farmers have become more involved in setting research and extension agendas. However, some negative aspects of sustainable agriculture and its advocates have also surfaced. Many of the systems being promoted require the substitution of labor/management/machinery for the currently-used practices. Wide-scale adoption of sustainable agriculture will require policy changes since food costs are policy controlled, markets are international in scope, and widespread increases in animal agriculture is unlikely. Current economics are favorably affected by using inputs and in many cases technology has been used to solve problems. From our perspective, we see a dichotomy developing within sustainable agriculture. Academics, policy makers, and spokes persons for sustainable agriculture recognize the many components and goals of sustainability, all oriented around improving research efficiency. To the practitioner, however, sustainable agriculture is equated to severely reduced or eliminated inputs. Second, the label appears to cause some apprehension on the part of some potential adopters and there does not appear to be an expanding audience willing to identify with the term. For these reasons, we believe that the concepts, issues, and practices associated with sustainable agriculture will become increasingly integrated into established programs, but that the label itself may well fall into disuse. The broader concept of the systems approach to research and extension will prevail, resulting in an ability to maintain communication with a variety of audience groups through more targeted programming.